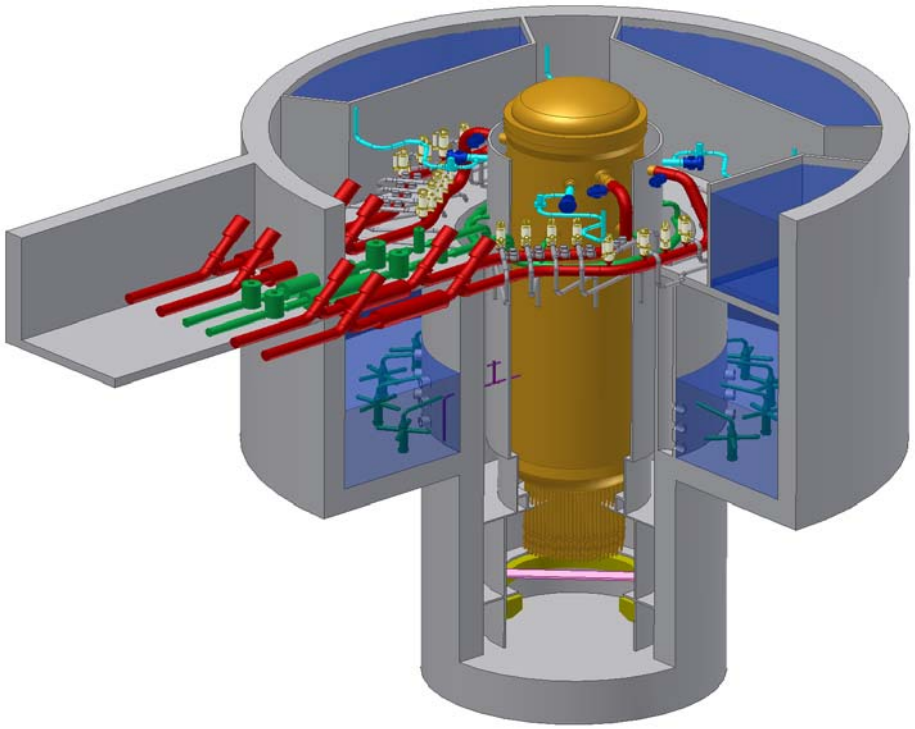
GE Nuclear Energy

26A6642AH
Revision 1
January 2006



ESBWR Design Control Document

Tier 2

Chapter 2

Site Characteristics

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Abbreviations And Acronyms

Term	Definition
10 CFR	Title 10, Code of Federal Regulations
A/D	Analog-to-Digital
AASHTO	American Association of Highway and Transportation Officials
AB	Auxiliary Boiler
ABS	Auxiliary Boiler System
ABWR	Advanced Boiling Water Reactor
ac / AC	Alternating Current
AC	Air Conditioning
ACF	Automatic Control Function
ACI	American Concrete Institute
ACS	Atmospheric Control System
AD	Administration Building
ADS	Automatic Depressurization System
AEC	Atomic Energy Commission
AFIP	Automated Fixed In-Core Probe
AGMA	American Gear Manufacturer's Association
AHS	Auxiliary Heat Sink
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AL	Analytical Limit
ALARA	As Low As Reasonably Achievable
ALWR	Advanced Light Water Reactor
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOO	Anticipated Operational Occurrence
AOV	Air Operated Valve
API	American Petroleum Institute
APLHGR	Average Planar Linear Head Generation Rate
APRM	Average Power Range Monitor
APR	Automatic Power Regulator
APRS	Automatic Power Regulator System
ARI	Alternate Rod Insertion
ARMS	Area Radiation Monitoring System
ASA	American Standards Association
ASD	Adjustable Speed Drive
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
AST	Alternate Source Term
ASTM	American Society of Testing Methods

Term	Definition
AT	Unit Auxiliary Transformer
ATLM	Automated Thermal Limit Monitor
ATWS	Anticipated Transients Without Scram
AV	Allowable Value
AWS	American Welding Society
AWWA	American Water Works Association
B&PV	Boiler and Pressure Vessel
BAF	Bottom of Active Fuel
BHP	Brake Horse Power
BOP	Balance of Plant
BPU	Bypass Unit
BPWS	Banked Position Withdrawal Sequence
BRE	Battery Room Exhaust
BRL	Background Radiation Level
BTP	NRC Branch Technical Position
BTU	British Thermal Unit
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners Group
CAV	Cumulative absolute velocity
C&FS	Condensate and Feedwater System
C&I	Control and Instrumentation
C/C	Cooling and Cleanup
CB	Control Building
CBHVAC	Control Building HVAC
CCI	Core-Concrete Interaction
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
CIRC	Circulating Water System
CIS	Containment Inerting System
CIV	Combined Intermediate Valve
CLAVS	Clean Area Ventilation Subsystem of Reactor Building HVAC
CM	Cold Machine Shop
CMS	Containment Monitoring System
CMU	Control Room Multiplexing Unit
COL	Combined Operating License
COLR	Core Operating Limits Report
CONAVS	Controlled Area Ventilation Subsystem of Reactor Building HVAC
CPR	Critical Power Ratio
CPS	Condensate Purification System
CPU	Central Processing Unit

Term	Definition
CR	Control Rod
CRD	Control Rod Drive
CRDA	Control Rod Drop Accident
CRDH	Control Rod Drive Housing
CRDHS	Control Rod Drive Hydraulic System
CRGT	Control Rod Guide Tube
CRHA	Control Room Habitability Area
CRT	Cathode Ray Tube
CS&TS	Condensate Storage and Transfer System
CSDM	Cold Shutdown Margin
CS / CST	Condensate Storage Tank
CT	Main Cooling Tower
CTVCF	Constant Voltage Constant Frequency
CUF	Cumulative usage factor
CWS	Chilled Water System
D-RAP	Design Reliability Assurance Program
DAC	Design Acceptance Criteria
DAW	Dry Active Waste
DBA	Design Basis Accident
dc / DC	Direct Current
DCS	Drywell Cooling System
DCIS	Distributed Control and Information System
DEPSS	Drywell Equipment and Pipe Support Structure
DF	Decontamination Factor
D/F	Diaphragm Floor
DG	Diesel-Generator
DHR	Decay Heat Removal
DM&C	Digital Measurement and Control
DOF	Degree of freedom
DOI	Dedicated Operators Interface
DOT	Department of Transportation
dPT	Differential Pressure Transmitter
DPS	Diverse Protection System
DPV	Depressurization Valve
DR&T	Design Review and Testing
DS	Independent Spent Fuel Storage Installation
DTM	Digital Trip Module
DW	Drywell
EB	Electrical Building
EBAS	Emergency Breathing Air System

Term	Definition
EBHV	Electrical Building HVAC
ECCS	Emergency Core Cooling System
E-DCIS	Essential DCIS (Distributed Control and Information System)
EDO	Environmental Qualification Document
EFDS	Equipment and Floor Drainage System
EFPY	Effective full power years
EHC	Electrohydraulic Control (Pressure Regulator)
ENS	Emergency Notification System
EOC	Emergency Operations Center
EOC	End of Cycle
EOF	Emergency Operations Facility
EOP	Emergency Operating Procedures
EPDS	Electric Power Distribution System
EPG	Emergency Procedure Guidelines
EPRI	Electric Power Research Institute
EQ	Environmental Qualification
ERICP	Emergency Rod Insertion Control Panel
ERIP	Emergency Rod Insertion Panel
ESF	Engineered Safety Feature
ETS	Emergency Trip System
FAC	Flow-Accelerated Corrosion
FAPCS	Fuel and Auxiliary Pools Cooling System
FATT	Fracture Appearance Transition Temperature
FB	Fuel Building
FBFPHV	Fuel Building Fuel Pool Area HVAC
FBGAHV	Fuel Building General Area HVAC
FBHV	Fuel Building HVAC
FCI	Fuel-Coolant Interaction
FCM	File Control Module
FCS	Flammability Control System
FCU	Fan Cooling Unit
FDDI	Fiber Distributed Data Interface
FFT	Fast Fourier Transform
FFWTR	Final Feedwater Temperature Reduction
FHA	Fire Hazards Analysis
FIV	Flow-Induced Vibration
FMCRD	Fine Motion Control Rod Drive
FMEA	Failure Modes and Effects Analysis
FPS	Fire Protection System
FO	Diesel Fuel Oil Storage Tank

Term	Definition
FOAKE	First-of-a-Kind Engineering
FPE	Fire Pump Enclosure
FTDC	Fault-Tolerant Digital Controller
FTS	Fuel Transfer System
FW	Feedwater
FWCS	Feedwater Control System
FWS	Fire Water Storage Tank
GCS	Generator Cooling System
GDC	General Design Criteria
GDCS	Gravity-Driven Cooling System
GE	General Electric Company
GE-NE	GE Nuclear Energy
GEN	Main Generator System
GETAB	General Electric Thermal Analysis Basis
GL	Generic Letter
GM	Geiger-Mueller Counter
GM-B	Beta-Sensitive GM Detector
GSIC	Gamma-Sensitive Ion Chamber
GSOS	Generator Sealing Oil System
GWSR	Ganged Withdrawal Sequence Restriction
HAZ	Heat-Affected Zone
HCU	Hydraulic Control Unit
HCW	High Conductivity Waste
HDVS	Heater Drain and Vent System
HEI	Heat Exchange Institute
HELB	High Energy Line Break
HEP	Human error probability
HEPA	High Efficiency Particulate Air/Absolute
HFE	Human Factors Engineering
HFF	Hollow Fiber Filter
HGCS	Hydrogen Gas Cooling System
HIC	High Integrity Container
HID	High Intensity Discharge
HIS	Hydraulic Institute Standards
HM	Hot Machine Shop & Storage
HP	High Pressure
HPNSS	High Pressure Nitrogen Supply System
HPT	High-pressure turbine
HRA	Human Reliability Assessment
HSI	Human-System Interface

Term	Definition
HSSS	Hardware/Software System Specification
HVAC	Heating, Ventilation and Air Conditioning
HVS	High Velocity Separator
HWCS	Hydrogen Water Chemistry System
HWS	Hot Water System
HX	Heat Exchanger
I&C	Instrumentation and Control
I/O	Input/Output
IAS	Instrument Air System
IASCC	Irradiation Assisted Stress Corrosion Cracking
IBC	International Building Code
IC	Ion Chamber
IC	Isolation Condenser
ICD	Interface Control Diagram
ICS	Isolation Condenser System
IE	Inspection and Enforcement
IEB	Inspection and Enforcement Bulletin
IED	Instrument and Electrical Diagram
IEEE	Institute of Electrical and Electronic Engineers
IGSCC	Intergranular Stress Corrosion Cracking
IIS	Iron Injection System
ILRT	Integrated Leak Rate Test
IOP	Integrated Operating Procedure
IMC	Induction Motor Controller
IMCC	Induction Motor Controller Cabinet
IRM	Intermediate Range Monitor
ISA	Instrument Society of America
ISI	In-Service Inspection
ISLT	In-Service Leak Test
ISM	Independent Support Motion
ISMA	Independent Support Motion Response Spectrum Analysis
ISO	International Standards Organization
ITA	Inspections, Tests or Analyses
ITAAC	Inspections, Tests, Analyses and Acceptance Criteria
ITA	Initial Test Program
LAPP	Loss of Alternate Preferred Power
LCO	Limiting Conditions for Operation
LCW	Low Conductivity Waste
LD	Logic Diagram
LDA	Lay down Area

Term	Definition
LD&IS	Leak Detection and Isolation System
LERF	Large early release frequency
LFCV	Low Flow Control Valve
LHGR	Linear Heat Generation Rate
LLRT	Local Leak Rate Test
LMU	Local Multiplexer Unit
LO	Dirty/Clean Lube Oil Storage Tank
LOCA	Loss-of-Coolant-Accident
LOFW	Loss-of-feedwater
LOOP	Loss of Offsite Power
LOPP	Loss of Preferred Power
LP	Low Pressure
LPCI	Low Pressure Coolant Injection
LPCRD	Locking Piston Control Rod Drive
LPMS	Loose Parts Monitoring System
LPRM	Local Power Range Monitor
LPSP	Low Power Setpoint
LWMS	Liquid Waste Management System
MAAP	Modular Accident Analysis Program
MAPLHGR	Maximum Average Planar Linear Head Generation Rate
MAPRAT	Maximum Average Planar Ratio
MBB	Motor Built-In Brake
MCC	Motor Control Center
MCES	Main Condenser Evacuation System
MCPR	Minimum Critical Power Ratio
MCR	Main Control Room
MCRP	Main Control Room Panel
MELB	Moderate Energy Line Break
MLHGR	Maximum Linear Heat Generation Rate
MMI	Man-Machine Interface
MMIS	Man-Machine Interface Systems
MOV	Motor-Operated Valve
MPC	Maximum Permissible Concentration
MPL	Master Parts List
MS	Main Steam
MSIV	Main Steam Isolation Valve
MSL	Main Steamline
MSLB	Main Steamline Break
MSLBA	Main Steamline Break Accident
MSR	Moisture Separator Reheater

Term	Definition
MSV	Mean Square Voltage
MT	Main Transformer
MTTR	Mean Time To Repair
MWS	Makeup Water System
NBR	Nuclear Boiler Rated
NBS	Nuclear Boiler System
NCIG	Nuclear Construction Issues Group
NDE	Nondestructive Examination
NE-DCIS	Non-Essential Distributed Control and Information System
NDRC	National Defense Research Committee
NDT	Nil Ductility Temperature
NFPA	National Fire Protection Association
NIST	National Institute of Standard Technology
NMS	Neutron Monitoring System
NOV	Nitrogen Operated Valve
NPHS	Normal Power Heat Sink
NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission
NRHX	Non-Regenerative Heat Exchanger
NS	Non-seismic
NSSS	Nuclear Steam Supply System
NT	Nitrogen Storage Tank
NTSP	Nominal Trip Setpoint
O&M	Operation and Maintenance
O-RAP	Operational Reliability Assurance Program
OBCV	Overboard Control Valve
OBE	Operating Basis Earthquake
OGS	Offgas System
OHLHS	Overhead Heavy Load Handling System
OIS	Oxygen Injection System
OLMCPR	Operating Limit Minimum Critical Power Ratio
OLU	Output Logic Unit
OOS	Out-of-service
ORNL	Oak Ridge National Laboratory
OSC	Operational Support Center
OSHA	Occupational Safety and Health Administration
OSI	Open Systems Interconnect
P&ID	Piping and Instrumentation Diagram
PA/PL	Page/Party-Line
PABX	Private Automatic Branch (Telephone) Exchange

Term	Definition
PAM	Post Accident Monitoring
PAR	Passive Autocatalytic Recombiner
PAS	Plant Automation System
PASS	Post Accident Sampling Subsystem of Containment Monitoring System
PCC	Passive Containment Cooling
PCCS	Passive Containment Cooling System
PCT	Peak cladding temperature
PCV	Primary Containment Vessel
PFD	Process Flow Diagram
PGA	Peak Ground Acceleration
PGCS	Power Generation and Control Subsystem of Plant Automation System
PH	Pump House
PL	Parking Lot
PM	Preventive Maintenance
PMCS	Performance Monitoring and Control Subsystem of NE-DCIS
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PQCL	Product Quality Check List
PRA	Probabilistic Risk Assessment
PRMS	Process Radiation Monitoring System
PRNM	Power Range Neutron Monitoring
PS	Plant Stack
PSD	Power Spectra Density
PSS	Process Sampling System
PSWS	Plant Service Water System
PT	Pressure Transmitter
PWR	Pressurized Water Reactor
QA	Quality Assurance
RACS	Rod Action Control Subsystem
RAM	Reliability, Availability and Maintainability
RAPI	Rod Action and Position Information
RAT	Reserve Auxiliary Transformer
RB	Reactor Building
RBC	Rod Brake Controller
RBCC	Rod Brake Controller Cabinet
RBCWS	Reactor Building Chilled Water Subsystem
RBHV	Reactor Building HVAC
RBS	Rod Block Setpoint
RBV	Reactor Building Vibration
RC&IS	Rod Control and Information System

Term	Definition
RCC	Remote Communication Cabinet
RCCV	Reinforced Concrete Containment Vessel
RCCWS	Reactor Component Cooling Water System
RCPB	Reactor Coolant Pressure Boundary
RCS	Reactor Coolant System
RDA	Rod Drop Accident
RDC	Resolver-to-Digital Converter
REPAVS	Refueling and Pool Area Ventilation Subsystem of Fuel Building HVAC
RFP	Reactor Feed Pump
RG	Regulatory Guide
RHR	residual heat removal (function)
RHX	Regenerative Heat Exchanger
RMS	Root Mean Square
RMS	Radiation Monitoring Subsystem
RMU	Remote Multiplexer Unit
RO	Reverse Osmosis
ROM	Read-only Memory
RPS	Reactor Protection System
RPV	Reactor Pressure Vessel
RRPS	Reference Rod Pull Sequence
RSM	Rod Server Module
RSPC	Rod Server Processing Channel
RSS	Remote Shutdown System
RSSM	Reed Switch Sensor Module
RSW	Reactor Shield Wall
RTIF	Reactor Trip and Isolation Function(s)
RT_{NDT}	Reference Temperature of Nil-Ductility Transition
RTP	Reactor Thermal Power
RW	Radwaste Building
RWCU/SDC	Reactor Water Cleanup/Shutdown Cooling
RWE	Rod Withdrawal Error
RWM	Rod Worth Minimizer
SA	Severe Accident
SAR	Safety Analysis Report
SB	Service Building
S/C	Digital Gamma-Sensitive GM Detector
SC	Suppression Chamber
S/D	Scintillation Detector
S/DRSRO	Single/Dual Rod Sequence Restriction Override
S/N	Signal-to-Noise

Term	Definition
S/P	Suppression Pool
SAS	Service Air System
SB&PC	Steam Bypass and Pressure Control System
SBO	Station Blackout
SBWR	Simplified Boiling Water Reactor
SCEW	System Component Evaluation Work
SCRRI	Selected Control Rod Run-in
SDC	Shutdown Cooling
SDM	Shutdown Margin
SDS	System Design Specification
SEOA	Sealed Emergency Operating Area
SER	Safety Evaluation Report
SF	Service Water Building
SFP	Spent fuel pool
SIL	Service Information Letter
SIT	Structural Integrity Test
SIU	Signal Interface Unit
SJAE	Steam Jet Air Ejector
SLC	Standby Liquid Control
SLCS	Standby Liquid Control System
SLMCPR	Safety Limit Minimum Critical Power Ratio
SMU	SSLC Multiplexing Unit
SOV	Solenoid Operated Valve
SP	Setpoint
SPC	Suppression Pool Cooling
SPDS	Safety Parameter Display System
SPTMS	Suppression Pool Temperature Monitoring Subsystem of Containment Monitoring System
SR	Surveillance Requirement
SRM	Source Range Monitor
SRNM	Startup Range Neutron Monitor
SRO	Senior Reactor Operator
SRP	Standard Review Plan
SRS	Software Requirements Specification
SRSRO	Single Rod Sequence Restriction Override
SRSS	Sum of the squares
SRV	Safety Relief Valve
SRVDL	Safety relief valve discharge line
SSAR	Standard Safety Analysis Report
SSC(s)	Structure, System and Component(s)
SSE	Safe Shutdown Earthquake

Term	Definition
SSLC	Safety System Logic and Control
SSPC	Steel Structures Painting Council
ST	Spare Transformer
STP	Sewage Treatment Plant
STRAP	Scram Time Recording and Analysis Panel
STRP	Scram Time Recording Panel
SV	Safety Valve
SWH	Static water head
SWMS	Solid Waste Management System
SY	Switch Yard
TAF	Top of Active Fuel
TASS	Turbine Auxiliary Steam System
TB	Turbine Building
TBCE	Turbine Building Compartment Exhaust
TBE	Turbine Building Exhaust
TBLOE	Turbine Building Lube Oil Area Exhaust
TBS	Turbine Bypass System
TBHV	Turbine Building HVAC
TBV	Turbine Bypass Valve
TC	Training Center
TCCWS	Turbine Component Cooling Water System
TCS	Turbine Control System
TCV	Turbine Control Valve
TDH	Total Developed Head
TEMA	Tubular Exchanger Manufacturers' Association
TFSP	Turbine first stage pressure
TG	Turbine Generator
TGSS	Turbine Gland Seal System
THA	Time-history accelerograph
TLOS	Turbine Lubricating Oil System
TLU	Trip Logic Unit
TMI	Three Mile Island
TMSS	Turbine Main Steam System
TRM	Technical Requirements Manual
TS	Technical Specification(s)
TSC	Technical Support Center
TSI	Turbine Supervisory Instrument
TSV	Turbine Stop Valve
UBC	Uniform Building Code
UHS	ultimate heat sink

Term	Definition
UL	Underwriter's Laboratories Inc.
UPS	Uninterruptible Power Supply
USE	Upper Shelf Energy
USM	Uniform Support Motion
USMA	Uniform support motion response spectrum analysis
USNRC	United States Nuclear Regulatory Commission
USS	United States Standard
UV	Ultraviolet
V&V	Verification and Validation
Vac / VAC	Volts Alternating Current
Vdc / VDC	Volts Direct Current
VDU	Video Display Unit
VW	Vent Wall
VWO	Valves Wide Open
WD	Wash Down Bays
WH	Warehouse
WS	Water Storage
WT	Water Treatment
WW	Wetwell
XMFR	Transformer
ZPA	Zero period acceleration

2. SITE CHARACTERISTICS

2.0 INTRODUCTION

This chapter defines the envelope of site-related parameters that the ESBWR Reference Plant is designed to accommodate. These parameters envelope most potential sites in the U.S. A summary of the site envelope design parameters is given in Table 2.0-1.

The particular site characteristics information will be provided in the Combined Operating License (COL) applicant's safety analysis report (SAR) in accordance with 10 CFR 52.79. Sections 2.1 through 2.5 of this chapter, which is the same format as Chapter 2 of NUREG-0800 Standard Review Plan (SRP), define the limits imposed on the SRP Section II acceptance criteria by (1) the envelope of site-related parameters that the ESBWR plant is designed to accommodate, and (2) the assumptions, both implicit and explicit, related to site characteristics employed in the evaluation of the ESBWR design.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.1.1	Site Location and Description	ESBWR parameters selected to envelope most potential sites in the U.S. COL applicant to supply site-specific information in accordance with SRP 2.1.1.
2.1.2	Exclusion Area Authority and Control	ESBWR design considers an area whose boundary has a Chi/Q less than or equal to 1.0×10^{-3} s/m^3. COL applicant to supply site-specific information in accordance with SRP 2.1.2.
2.1.3	Population Distribution	ESBWR DCD: None. COL applicant to describe the population distribution in accordance with SRP 2.1.3.
2.2.1 – 2.2.2	Identification of Potential Hazards in Site Vicinity	ESBWR DCD: No assumptions made regarding site-specific potential hazards. COL applicant to identify potential hazards in the site vicinity, in accordance with SRP 2.2.1 – 2.2.2., that have a probability of occurrence $>10^{-7}$ per year which produce: (1) missiles more energetic than the tornado missile spectra, or (2) pressure effects in excess of the design basis tornado.
2.2.3	Evaluation of Potential Accidents	ESBWR DCD: See ESBWR DCD sections 6.2, 6.3, and Chapter 15. In accordance with SRP 2.2.3 the COL applicant to evaluate those potential hazards identified in 2.2.1 – 2.2.2, above.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.3.1	Regional Climatology	ESBWR DCD: The basic speed of extreme winds used for design of safety-related structures is 62.6 m/sec (140 mph). The basic speed of extreme wind for nonsafety-related structures is 49.2m/s (110 mph). The following importance factors, as defined in ANSI A58.1, are used for scaling wind forces for types of structures: Safety-Related Structures 1.15 Nonsafety-Related Structures 1.00 The maximum design ambient temperature corresponding to a one percent exceedance value is 37.8°C (100°F) dry bulb with a coincident wet bulb temperature of 26.1°C (79°F) and 27.8°C (82°F) for non-coincident wet bulb. The minimum design temperature corresponding to a one percent exceedance value is -23.3°C (-10°F). The zero percent exceedance dry bulb temperature is 46.1°C (115°F) with a coincident wet bulb temperature of 26.7°C (80°F) and 29.4°C (85 °F) for non-coincident wet bulb. The minimum temperature for this exceedance value is -40°C (-40°F); The maximum rainfall rate for roof design is 49.3cm/h (19.4 in./h), which is based on the probable maximum precipitation (PMP) for one hour over one square mile with a ratio of 5 minutes to one hour PMP of 0.32, as found in National Weather Service Publication HMR No. 52. The maximum short-term rainfall rate is 15.7cm (6.2 in.). The maximum snow load for roof design is 2394 Pa (50 lbf/ sq ft). The maximum tornado wind speed is 147.5m/s (330 mph), with a translational velocity of 31.3m/s (70 mph), and a radius of 45.7m (150 ft). The maximum atmospheric pressure differential is 16.6 kPa (2.4 psi) and the rate of pressure change is 11.7 kPa/s (1.7 psi/s). The missile spectra is per Spectra I of Standard Review Plan 3.5.1.4. COL applicant to confirm or reanalyze in accordance with SRP 2.3.1.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.3.2	Local Meteorology	ESBWR DCD: None; see subsection 2.3.1 of this table for ESBWR bounding parameters. COL applicant to supply site-specific information in accordance with SRP 2.3.2.
2.3.3	Onsite Meteorological Measurement Programs	ESBWR DCD: None; see subsection 2.3.1 for ESBWR bounding parameters.. COL applicant to supply site-specific information in accordance with the SRP 2.3.3.
2.3.4	Short-Term Diffusion Estimates for Accidental Atmospheric Releases	ESBWR DCD: See Chapter 15. COL applicant to supply site-specific information in accordance with the SRP 2.3.4 to show that the site meteorological dispersion values as calculated in accordance with Regulatory Guide 1.145, and compared to dose values given in Chapter 15, result in doses less than stipulated in 10 CFR 50.34(a) and the applicable portions of SRP Sections 11 and 15.
2.3.5	Long-Term Diffusion Estimates	ESBWR long-term diffusion estimates are given in Chapter 12. COL applicant to supply site-specific information in accordance with the SRP 2.3.5.
2.4.1	Hydraulic Description Maximum Ground Water Level	ESBWR DCD: 0.61 m (2 ft) below grade. COL applicant to supply site-specific information in accordance with the SRP 2.4.1.
2.4.2	Floods	ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels. Penetrations and access openings below grade shall be watertight. COL applicant to supply site-specific information in accordance with the SRP 2.4.2.
2.4.3	Probable Maximum Flood on Streams and Rivers	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is 0.3m (1 ft) below grade or less. COL applicant to supply site-specific information in accordance with the SRP 2.4.3.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.4.4	Potential Dam Failures Seismically Induced	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is at least 0.3m (1 ft) below grade. COL applicant to supply site-specific information in accordance with the SRP 2.4.4.
2.4.5	Probable Maximum Surge and Seiche Flooding	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is at least 0.3m (1 ft) below grade. COL applicant to supply site-specific information in accordance with the SRP 2.4.5.
2.4.6	Probable Maximum Tsunami	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is at least 0.3m (1 ft) below grade. COL applicant to supply site-specific information in accordance with the SRP 2.4.6.
2.4.7	Ice Effects	ESBWR DCD: None; the plant design has no safety-related service water system to be affected by ice flooding or blockage. COL applicant to supply site-specific information in accordance with the SRP 2.4.7.
2.4.8	Cooling Water Channels and Reservoirs	ESBWR DCD: None; the plant design has no safety-related service water system that would require transport and impoundment of plant cooling water COL applicant to supply site-specific information in accordance with the SRP 2.4.8.
2.4.9	Channel Diversion	ESBWR DCD: None; the plant design has no safety-related service water system that would be adversely affected by natural stream channel diversion. COL applicant to supply site-specific information in accordance with the SRP 2.4.9.
2.4.10	Flooding Protection Requirements	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is at least 0.3m (1 ft) below grade. COL applicant to supply site-specific information in accordance with the SRP 2.4.10.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.4.11	Cooling Water Supply	ESBWR DCD: None; the plant design has no safety-related service water system that would require that a water supply exist to operate the plant or maintain safe shutdown under normal and emergency conditions. COL applicant to supply site-specific information in accordance with the SRP 2.4.11.
2.4.12	Groundwater	ESBWR DCD: At least 0.61.0 m (2 ft) below grade. COL applicant to supply site-specific information in accordance with the SRP 2.4.12.
2.4.13	Accidental Releases of Liquid Effluents in Ground and Surface Waters	ESBWR DCD: See DCD Tier-2 Chapter 15 "Liquid Containing Tank Failure" COL applicant to supply site-specific information in accordance with the SRP 2.4.13.
2.4.14	Technical Specifications and Emergency Operation Requirement	ESBWR see DCD Tier-2 Chapters 16 and 18. COL applicant to provide site-specific information in accordance with SRP 2.4.14.
2.5.1	Basic Geology and Seismic Information	ESBWR DCD: See subsections 2.5.2-2.5.5 of this table for ESBWR bounding parameters. COL applicant to provide site-specific information in accordance with SRP 2.5.1.
2.5.2	Vibratory Ground Motion:	ESBWR DCD: Safe Shutdown Earthquake (SSE) design ground response spectra are the envelope of 0.3g Regulatory Guide 1.60 generic site spectra and North Anna ESP site-specific spectra at foundation level in the free-field as shown in Figures 2.5-1 and 2.5-2 in the horizontal and vertical directions, respectively. COL applicant to provide site-specific information in accordance with SRP 2.5.2.
2.5.3	Surface Faulting	ESBWR design assumes no faulting at or near the ground surface. COL applicant to provide site-specific information in accordance with SRP 2.5.3.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.5.4	Stability of Subsurface Materials and Foundations	ESBWR minimum static bearing capacity of the soil: At least 718 kPa (15000 lbf/sq ft). ESBWR minimum shear wave velocity: 300m/s (984 fps). ESBWR design assumes no liquefaction potential resulting from an SSE. COL applicant to provide site-specific information in accordance with SRP 2.5.4.
2.5.5	Stability of Slopes	ESBWR design assumes stable slopes. COL applicant to provide site-specific information in accordance with SRP 2.5.5.

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site and Location Description

ESBWR parameters are presented in Table 2.0-1.

The COL applicant identifies the plant location and description in accordance with the requirements of SRP 2.1.1 to include the following:

Reactor location is presented

- as identified by latitude and longitude and by the UTM coordinate system;
- with respect to political subdivisions; and
- with respect to prominent natural and man-made features of the area to ascertain the accuracy of the applicant's safety analysis report (SAR) description and for use in independent reviews of the exclusion area authority and control (SRP Section 2.1.2), the surrounding population (SRP Subsection 2.1.3) and nearby man-made hazards (SRP Subsection 2.2.3).

The site area which contains the reactors and associated principal plant structures is described to identify the distance from the reactor to boundary lines of the exclusion area, including the direction and distance from the reactor to the nearest exclusion area boundary line. A scaled plot plan of the exclusion area is provided which permits distance measurements to the exclusion area boundary in each of the 22.5 degree segments centered on the 16 cardinal compass points. The location and orientation of plant structures within the exclusion area are presented to identify potential release points and their distances to exclusion area boundary lines. The location, distance, and orientation of plant structures with respect to highways, railways, and waterways, which traverse or lie adjacent to the exclusion area are presented to assure that they are adequately described to permit analyses (SRP Subsection 2.2.3) of the possible effects on the plant of accidents on these transportation routes.

The acceptability of the site location and description are based on meeting the relevant requirements of 10 CFR Part 50, §50.34 and 10 CFR Part 100, §100.10. The relevant requirements of these regulations are:

- 10 CFR Part 100, §100.10 as it relates to site acceptance being based on the consideration of factors relating to the proposed reactor design and the characteristics peculiar to the site.
- 10 CFR Part 50, §50.34 as it relates to the applicant submitting in its safety analysis reports information needed for evaluating factors involving the use characteristics of the site environs.

The information submitted by the applicant is adequate and meets the 10 CFR Part 50, §50.34 requirements if it satisfies the following criteria:

The site location including the exclusion area and the location of the plant within the area are described in sufficient detail to allow a determination (in Subsections 2.1.2, 2.1.3, and those in Chapter 15) that 10 CFR Part 100 is met.

Highways, railways, and waterways, which traverse the exclusion area, are sufficiently distant from plant structures so that routine use of these routes is not likely to interfere with normal plant operation.

Information included in this DCD Tier 2 subsection will allow two types of safety analyses to be conducted. The first addresses the consequences in the unlikely event that a serious release of radioactive material should occur. The second addresses the effect that accidents on, or routine use of, routes on or near the site will have on the operation of the plant.

2.1.2 Exclusion Area Authority and Control

ESBWR parameters are presented in Table 2.0-1.

The COL applicant describes the exclusion area authority and control in accordance with SRP 2.1.2 to include the following:

The applicant's legal authority to determine all activities within the designated exclusion area is described. 10 CFR Part 100, §100.3(a) requires that a reactor licensee have authority to determine all activities within the designated exclusion area, including the exclusion and removal of personnel and property.

In any case where the applicant does not own all the land, including mineral rights, within the designated exclusion area, assistance may be required of the Office of the Executive Legal Director (OELD) in determining whether or not the designated exclusion area meets the requirements of 10 CFR Part 100. Also, in some cases public roads that lie within the proposed exclusion area may have to be abandoned or relocated to permit plant construction. OELD assistance may be required to assure that no legal impediments to such abandonment or relocation are likely to ensue. Part 100 permits the exclusion area to be traversed by a highway, railway, or waterway provided arrangements are made to control these areas in event of an emergency.

Activities that may be permitted within the designated exclusion area, and that will not be related to routine operation of the plant, are described. The description will include the type of activity, its specific location within the exclusion area, the number and kinds of persons engaged in the activity, and the frequency and length of time the activities are to be permitted. Provisions will be made such that individuals associated with plant unrelated activities within the exclusion area can be evacuated prior to receiving doses in excess of the guideline values of 10 CFR 50.34(a).

The COL applicant demonstrates meeting the relevant requirements of 10 CFR Part 100 with respect to the applicant's legal authority with the designated exclusion area. 10 CFR Part 100 in Section 100.3(a) states as follows:

“Exclusion area” means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety. Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

To meet the requirements of 10 CFR Part 100 the applicant demonstrates that it has the authority within the exclusion area as required by Section 100.3(a), or must provide reasonable assurance that it will have such authority prior to start of construction. Absolute ownership of all lands within the exclusion area, including mineral rights, is considered to carry with it the required authority to determine all activities on this land and is acceptable.

Where the required authority is contingent upon future procurement of ownership (e.g., by eminent domain proceedings), or by lease, easement, contract, or other means, the exclusion area may be acceptable if the information provided by the applicant provides reasonable assurance that the required authority will be obtained prior to start of construction.

Activities unrelated to plant operation within the exclusion area are acceptable provided:

- Such activities, including accidents associated with such activities, represent no hazard to the plant or have been shown to be accommodated as part of the plant design basis (see SRP Subsection 2.2.3).
- The applicant is aware of such activities and has made appropriate arrangements to evacuate persons engaged in such activities, in the event of an accident, and
- There is reasonable assurance that persons engaged in such activities can be evacuated without receiving radiation doses in excess of the guideline values given in 10 CFR 50.34(a).

Where the designated exclusion area extends into bodies of water such as a lake, reservoir, or river, which is routinely accessible to the public, the applicant must have made appropriate arrangements with the local, state, Federal, or other public agency having authority over the particular body of water and the arrangements made provide for the exclusion and ready removal in an emergency, by either the applicant or the public agency in authority, of any persons on those portions of the body of water which lie within the designated exclusion area.

2.1.3 Population Distribution

ESBWR DCD: None, as noted in Table 2.0-1.

COL applicant to describe the population distribution in accordance with SRP 2.1.3 to include the following:

The population data in the site environs are presented in the COL applicant's SAR, to demonstrate that the exclusion area, low population zone and population center distance for the site comply with the requirements of 10 CFR Part 100.

The COL applicant presents the low population zone (LPZ), to demonstrate that there is reasonable assurance that appropriate protective measures can be taken in this area, in the event of emergency.

The COL applicant demonstrates meeting the relevant requirements of the following regulations:

- 10 CFR Part 50, §50.34 as it relates to having each applicant provide a description and safety assessment of the site in his SAR, with special attention to the site evaluation factors identified in 10 CFR Part 100.
- 10 CFR Part 100, §100.10 as it relates to determining the acceptability of a site for a power reactor. The applicant takes the following item, among others, into consideration.

Population density and use characteristics of the site environs, including the exclusion area, low population zone, and population center distance.

10 CFR Part 100 also provides definitions and other requirements for determining an exclusion area, low population zone, and population center distance in Sections 100.3 and 100.11, respectively.

The requirements of 10 CFR Part 50, §50.34 and 10 CFR Part 100 are deemed to have been met if the population density and use characteristics of the site meet the following:

- Either there are no residents in the exclusion area, or if so, such residents are subject to ready removal, in case of necessity.
- The specified low population zone is acceptable if it is determined that appropriate protective measures could be taken in behalf of the enclosed populace in the event of a serious accident.
- The nearest boundary of the closest population center (as defined in 10 CFR Part 100) is at least one and one third times the distance from the reactor to the outer boundary of the low population zone.
- The population center distance is acceptable if there are no likely concentrations of greater than 25,000 people over the plant lifetime closer than the distance designated by the applicant as the population center distance. The boundary of the population center shall be determined upon considerations of population distribution. Political boundaries are not controlling.
- The population data supplied by the applicant in his COL SAR is acceptable if
  - it contains population data for the latest census, projected year of plant startup and projected year of end of plant life, all in the geographical format given in Subsection 2.1.3 of Regulatory Guide 1.70;
  - it describes the methodology and sources used to obtain the population data, including the projections;
  - it includes information on transient populations in the site vicinity; and
  - the population data in the site vicinity, including projections, is verified by other means such as U.S. Census publications, publications from state and local governments, and other independent projections, to be reasonable.
- If the population density exceeds the guidelines given in Position C.3 of Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," the COL applicant will be required to give special attention to the consideration of alternative sites with lower population densities. A site that exceeds the population density guidelines of Position C.3 of Regulatory Guide 4.7 can nevertheless be selected and approved if, on balance, it offers advantages compared with available alternative sites when all of the environmental, safety, and economic aspects of the proposed and alternative sites are considered.

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

2.2.1 – 2.2.2 Identification of Potential Hazards in Site Vicinity

ESBWR DCD: No assumptions made regarding site-specific potential hazards.

The COL applicant describes the identification of potential hazards in the site vicinity in accordance with SRP 2.2.1 – 2.2.2 to include the following:

The site and its vicinity are presented including location and separation distance with respect to industrial, military, and transportation facilities and routes. Such facilities and routes include air, ground, and water traffic, pipelines, and fixed manufacturing, processing, and storage facilities. The description focuses on potential external hazards or hazardous materials that are present or which may reasonably be expected to be present during the projected lifetime of the plant. The purpose of this presentation is to establish the information concerning the presence and magnitude of potential external hazards so that the reviews and evaluations described in SRP Subsections 2.2.3, 3.5.1.5, and 3.5.1.6 can be performed. Control room habitability with respect to toxic chemicals and smoke is presented in Tier 2 Section 6.4.

10 CFR 100.10 requires that site acceptance be based on the consideration of factors relating to the proposed reactor design and the characteristics peculiar to the site. One of the factors involves the use characteristics of the site environs. In accordance with 10 CFR Part 50, §50.34, the COL applicant submits in the safety analysis report information needed for evaluating these factors. Guidelines for specific information requirements are described in Chapter 2, Sections 2.2.1 and 2.2.2 of Regulatory Guide (RG) 1.70.

The information submitted by the applicant is adequate and meets the 10 CFR Part 50, §50.34 and 10 CFR 100, §100.10 requirements and Regulatory Guide 1.70 guidelines if it satisfies the following criteria:

- Data in the COL SAR adequately describes the locations and distances of industrial, military, and transportation facilities in the vicinity of the plant, and is in agreement with data obtained from other sources, when available.
- Descriptions of the nature and extent of activities conducted at nearby facilities, including the products and materials likely to be processed, stored, used, or transported, are adequate to permit identification of possible hazards.
- Sufficient statistical data with respect to hazardous materials are provided to establish a basis for evaluating the potential hazard to the plant.

2.2.3 Evaluation of Postulated Accidents

ESBWR DCD: See Sections 6.2 and 6.3, and Chapter 15.

The COL applicant describes the evaluation of potential accidents in accordance with SRP 2.2.3 to include the following:

The applicant's identification of potential accident situations in the vicinity of the plant is presented to determine the completeness of and the bases upon which these potential accidents were accommodated in the design. (See Standard Review Plan Subsections 2.2.1 and 2.2.2.)

With respect to potential offsite accidents, which could affect control room habitability (e.g., toxic gases, asphyxiates), those accidents that are to be accommodated on a design basis, as

determined within SRP Subsection 2.2.3 review, will be addressed within the applicants SAR Section 6.4 in accordance with SRP Section 6.4 and TMI-Related Requirement III.D.3.4 of NUREG-0694.

The COL applicant's probability analyses of potential accidents involving hazardous materials or activities in the vicinity of the plant, if such analyses have been performed, are also presented to determine that appropriate data and analytical models have been utilized.

The analyses of the consequences of accidents involving nearby industrial, military, and transportation facilities, which have been identified as design basis events are presented.

Acceptance is based on meeting the relevant requirements of 10 CFR 50.34(a), §100.10 as it relates to the factors to be considered in the evaluation of sites, which indicates that reactors should reflect through their design, construction, and operation an extremely low probability for accidents that could result in the release of significant quantities of radioactive fission products. In addition, 10 CFR Part 100, §100.10 indicates that the site location, in conjunction with other considerations, should insure a low risk of public exposure.

Offsite hazards which have the potential for causing onsite accidents leading to the release of significant quantities of radioactive fission products, and thus pose an undue risk of public exposure, should have a sufficiently low probability of occurrence and be within the scope of the low probability of occurrence criterion of 10 CFR Part 100, §100.10. Specific guidance with respect to offsite hazards is provided in Chapter 2, Subsection 2.2.3 of Regulatory Guide (RG) 1.70. As indicated therein, the identification of design basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant is acceptable if the design basis events include each postulated type of accident for which the expected rate of occurrence of potential exposures in excess of the 10 CFR Part 100 guidelines is estimated to exceed the NRC staff objective of approximately 10^{-7} per year. Because of the difficulty of assigning accurate numerical values to the expected rate of unprecedented potential hazards generally considered in this section, judgment must be used as to the acceptability of the overall risk presented.

The probability of occurrence of the initiating events leading to potential consequences in excess of 10 CFR 50.34(a) exposure guidelines should be estimated using assumptions that are as representative of the specific site as is practicable. In addition, because of the low probabilities of the events under consideration, data are often not available to permit accurate calculation of probabilities. Accordingly, the expected rate of occurrence of potential exposures in excess of the 10 CFR Part 100 guidelines of approximately 10^{-6} per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The effects of design basis events have been adequately considered if analyses of the effects of those accidents on the safety-related features of the plant have been performed and measures have been taken (e.g., hardening, fire protection) to mitigate the consequences of such events.

2.3 METEOROLOGY

2.3.1 Regional Climatology

ESBWR DCD: See Item 2.3.1 of Table 2.0-1 for ESBWR bounding parameters.

COL applicant shall provide information in accordance with SRP 2.3.1 concerning averages and extremes of climatic conditions and regional meteorological phenomena, which affect the safe design and siting of the plant. The review covers the following specific areas:

- A description of the general climate of the region with respect to types of air masses, synoptic features (high and low pressure systems and frontal systems), general airflow patterns (wind direction and speed), temperature and humidity, precipitation (rain, snow, and sleet), and relationships between synoptic-scale atmospheric processes and local (site) meteorological conditions.
- Seasonal and annual frequencies of severe weather phenomena including tornadoes, waterspouts, thunderstorms, lightning, hail (including probable maximum size), and high air pollution potential.
- Meteorological conditions used as design and operating bases including:
  - The maximum snow and ice load (water equivalent) that the roofs of safety-related structures must be capable of withstanding during plant operation.
  - Ultimate heat sink meteorological conditions resulting in maximum evaporation and drift loss of water and minimum water cooling.
  - Tornado parameters including translational speed, rotational speed, and the maximum pressure differential with the associated time interval.
  - 100-year return period “fastest mile of wind” including vertical velocity distribution and gust factor.
  - Probable maximum annual frequency of occurrence and time duration of freezing rain (ice storms) and, where applicable, dust (sand) storms.
  - Other meteorological and air quality conditions used for design and operating basis considerations.

The information regarding the regional meteorological conditions and phenomena, which affect the safe design and siting of the plant, is acceptable if it meets the requirements of the following regulations:

- 10 CFR Part 50, Appendix A, General Design Criterion 2 (GDC 2), “Design Bases for Protection Against Natural Phenomena”, with respect to information on severe regional weather phenomena that have historically been reported for the region and that are reflected in the design bases for structures, systems and components important to safety,
- 10 CFR Part 50, Appendix A, General Design Criterion 4 (GDC 4), “Environmental Missile Design Bases”, with respect to information on tornadoes that could generate missiles, and
- 10 CFR Part 100, §100.10(c), with respect to the consideration that has been given to the regional meteorological characteristics of the site.

2.3.2 Local Meteorology

ESBWR DCD: None; see Item 2.3.1 of Table 2.0-1 for ESBWR bounding parameters.

Information is presented by the COL applicant in accordance with SRP 2.3.2 concerning the local (site) meteorological parameters, an assessment of the potential influence of the plant and its facilities on local meteorological conditions, and a topographical description of the site and its environs. The information covers the following specific areas.

- A description of the local (site) meteorology in terms of airflow, temperature, atmospheric water vapor, precipitation, fog, atmospheric stability, and air quality.
- An assessment of the influence of the plant and its facilities on the local meteorological parameters listed in (1), including the effects of plant structures, terrain modification, and heat and moisture sources due to plant operation.
- A topographical description of the site and its environs, as modified by the plant structures, including the site boundary, exclusion zone, and low population zone.

The information regarding the local meteorological and topographic descriptions of the site area applicable both before plant construction and during plant operation should be adequately documented such that meteorological impacts on plant design and operation as well as the impact of the plant on local meteorological conditions can be reliably predicted. The information should be fully documented and substantiated as to its representativeness of conditions at and near the site. The information is acceptable if it meets the requirements of the following regulations:

- 10 CFR Part 50, Appendix A, General Design Criterion 2 (GDC 2), "Design Bases for Protection Against Natural Phenomena," with respect to information on the most severe local weather phenomena that have historically been reported for the site and the surrounding area and that are reflected in the design bases for structures, systems, and components important to safety,
- 10 CFR Part 100, §100.10(c) with respect to the consideration that has been given to the local meteorological and air quality characteristics of the site and other physical characteristics of the site that can influence the local meteorology.

2.3.3 On-site Meteorological Measurements Program

ESBWR DCD: None; see Item 2.3.1 of Table 2.0-1 for ESBWR bounding parameters. Information is presented by the COL applicant in accordance with SRP 2.3.3 concerning the onsite meteorological measurements programs including instrumentation and measured data. The information covers the following specific areas:

- Meteorological instrumentation including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, and data acquisition and reduction procedures.
- Meteorological data including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions.
- Additional meteorological measurement requirements for emergency preparedness planning pursuant to 10 CFR Part 50, §50.47 and Appendix E to 10 CFR Part 50.

Acceptance criteria for the onsite meteorological measurement program are based on the relevant requirements of the following regulations:

- 10 CFR Part 100, §100.10(c)(2) as related to meteorological data collected for use in characterizing meteorological conditions of the site and surrounding area.
- 10 CFR Part 100, §100.11(a) as related to meteorological data used in the evaluation to determine an exclusion area and a low population zone.
- 10 CFR Part 50, Appendix I as related to meteorological data used in determining the compliance with the numerical guides for doses to meet the criterion of "as low as is reasonably achievable".

2.3.4 Short-Term Diffusion Estimates for Accidental Atmospheric Releases

ESBWR DCD: See Section 15.4.

COL applicant to provide information, in accordance with SRP 2.3.4, concerning atmospheric dispersion estimates for postulated accidental releases of effluents to the atmosphere. The information covers the following specific areas:

- Atmospheric transport and diffusion models to calculate relative concentrations for postulated accidental radioactive and hazardous airborne releases.
- Meteorological data summaries used as input to diffusion models.
- Derivation of diffusion parameters.
- Probability distributions of relative concentrations.
- Determination of relative concentrations used for assessment of consequences of postulated radioactive atmospheric releases for design basis accidents and for other accidents, and of onsite and offsite hazardous airborne releases.

The COL applicant provides conservative estimates of atmospheric transport and diffusion conditions at appropriate distances from the source for postulated accidental releases of radioactive and hazardous materials to the atmosphere. The plant is considered as both a source and a receptor.

The information is provided to demonstrate compliance with the following regulations:

- 10 CFR Part 50, Appendix A, General Design Criterion 19 (GDC 19), "Control Room", with respect to the meteorological considerations used to evaluate the personnel radiation exposures inside the control room during design basis accident conditions.
- 10 CFR Part 100, §100.11(a), with respect to the meteorological considerations used in the evaluation to determine an acceptable exclusion area and low population zone. Regulatory Guides that provide information, recommendations and guidance and in general describe an acceptable basis to implement the requirements of GDC 19 and 10 CFR Part 100 include Regulatory Guides 1.5, 1.23, 1.24, 1.25, 1.77, 1.78, and 1.145 (Refs. 3, 4, 5, 6, 7, 8, 9, and 10).

ESBWR short-term diffusion estimates are given in Section 15.4. The COL applicant will provide short-term diffusion estimates in accordance with Regulatory Guide 1.145 for comparison to dose values given in Section 15.4. They are shown to result in doses less than stipulated in 10 CFR 50.34(a) and in the applicable portions of SRP Sections 11 and 15.

2.3.5 Long-Term Diffusion Estimates

ESBWR long-term diffusion estimates are given within Chapter 12.

Information is presented by the COL applicant in accordance with SRP 2.3.5 concerning atmospheric diffusion estimates for routine releases of effluents to the atmosphere. The presentation reviews the following specific areas:

- Atmospheric dispersion models to calculate concentrations in air and amount of material deposited as a result of routine releases of radioactive material to the atmosphere.
- Meteorological data used as input to diffusion models.
- Derivation of diffusion parameters.
- Relative concentration (X/Q) and relative deposition (D/Q) values used for assessment of consequences of routine airborne radioactive releases.

The presentation reviews the locations of potential receptors for dose computations.

Characterization of atmospheric transport and diffusion conditions is provided for estimating the radiological consequences of routine releases of radioactive materials to the atmosphere to demonstrate compliance with the numerical guides for doses contained in 10 CFR Part 50, Appendix I.

The following regulatory guides provide acceptable criteria for complying with this subsection:

- Regulatory Guide 1.109 presents identification criteria to be used for specific receptors of interest.
- Regulatory Guide 1.111 provides criteria for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases. Use of the model described in NUREG-0324 is acceptable.
- Regulatory Guide 1.112 presents identification criteria to be used for release points and release characteristics.

2.4 HYDROLOGIC ENGINEERING

2.4.1 Hydrologic Description

The ESBWR hydrologic description is presented in Subsection 2.4.1 of Table 2.0-1.

In accordance with SRP 2.4.1, in this subsection the COL applicant presents the following site-specific information:

- Identification of the interface of the plant with the hydrosphere.
- Identification of hydrologic causal mechanisms that may require special plant design bases or operating limitations with regard to floods and water supply requirements.
- Identification of surface and groundwater uses that may be affected by plant operation.

2.4.1.1 Site and Facilities

In this subsection the COL applicant compares the independently verified or derived hydrologic design bases (see subsequent sections of 2.4) with the critical elevations of safety-related structures and facilities.

2.4.1.2 Hydrosphere

In this subsection the COL applicant presents the hydrologic characteristics of streams, lakes (e.g., location, size, shape, drainage area), shore regions, the regional and local groundwater environments, and existing or proposed water control structures (upstream and downstream) influencing the type of flooding mechanisms which may adversely effect safety aspects of plant siting and operation.

Acceptance criteria for SRP 2.4.1 relate to the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes, floods, tsunami, and seiches.
- 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site.

2.4.2 Floods

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

In this subsection of the safety analysis report (SAR) the COL applicant identifies historical flooding (defined as occurrences of abnormally high water stage or overflow from a stream, floodway, lake, or coastal area) at the proposed site or in the region of the site. The applicant summarizes and identifies the individual types of flood-producing phenomena, and combinations of flood-producing phenomena, considered in establishing the flood design bases for safety-related plant features. It also covers the potential effects of local intense precipitation. Although topical information may appear in COL SAR Subsections 2.4.3 through 2.4.7, the types of events considered and the controlling event are reviewed in this section of the COL SAR.

The flood history and the potential for flooding are presented for the following sources and events. Factors affecting potential runoff (such as urbanization, forest fire, or change in agricultural use), erosion, and sediment deposition are considered in the presentation.

- Stream flooding
  - Probable Maximum Flood (PMF) with coincident wind-induced waves, considering dam failure potential due to inadequate capacity, inadequate flood discharge capability, or existing physical condition.
  - Ice jams, both independently and coincident with a winter probable maximum storm.
  - Tributary drainage area PMF potential.
  - Combinations of less severe river floods, coincident with surges and seiches.
- Surges
  - Probable Maximum Hurricane (PMH) at coastal sites.
  - PMH wind translated inland and resulting wave action coincident with runoff-induced flood levels.
  - Probable maximum wind-induced (non-hurricane) storm surges and waves.
  - Combinations of less severe surges, coincident with runoff floods.
- Seiches
  - Meteorologically induced in inland lakes (e.g., Great Lakes and harbors) and at coastal harbors and embayments.
  - Seismically induced in inland lakes.
  - Seismically induced by tsunami (seismic sea waves) on coastal embayments.
  - Combinations of less severe surges and seiches, coincident with runoff floods.
- Tsunami
  - Near field, or local, excitation.
  - Far field, or distant, excitation.
- Seismically induced dam failures (or breaches) and maximum water level at site from:
  - Failure of dam (or dams) during Safe Shutdown Earthquake (SSE) coincident with 25-year flood.
  - Failure during other earthquakes, coincident with runoff, surge, or seiche floods where the coincidence is at least as likely as for failure of a dam (above).
- Flooding caused by landslides
  - Flood waves.
  - Backwater effects due to stream blockage.
- Ice loadings from water bodies

Acceptance criteria for SRP 2.4.2 relate to the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes, floods, tsunami, seiches.

- 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site.

To meet the requirements of the hydrologic aspects of GDC 2 and 10 CFR Part 100, the following specific investigations and criteria are used:

2.4.2.1 Flood History

In this subsection the COL applicant presents the potential flood sources and flood response.

2.4.2.2 Flood Design Considerations

In this subsection the COL applicant presents an estimate of controlling flood levels.

2.4.2.3 Effects of Local Intense Precipitation

In this subsection the COL applicant estimates the local Probable Maximum Precipitation (PMP) and the capacity of site drainage facilities (including drainage from the roofs of buildings and site) relating to the potential for any adverse effects of blockage of site drainage facilities by debris, ice, or snow based upon conservative assumptions of storm and vegetation conditions likely to exist during storm periods. If a potential hazard does exist, the COL applicant shall document and justify his local PMP basis and analysis and design of any affected facilities.

Appropriate sections of the following documents are used to develop the COL applicant's data and analyses in meeting the requirements of GDC 2 and 10 CFR Part 100. Regulatory Guide 1.59 provides guidance for estimating the design basis for flooding considering the worst single phenomenon and combinations of less severe phenomena.

Regulatory Guide 1.29 identifies the safety-related structures, systems, and components, and Regulatory Guide 1.102 describes acceptable flood protection to prevent the safety-related facilities from being adversely affected. Publications of the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Soil Conservation Service (SCS), Corps of Engineers, applicable State and river basin authorities, and other similar agencies are used to verify the applicant's data relating to hydrologic characteristics and extreme events in the region. SRP subsections 2.4.3 through 2.4.7 discuss methods of analysis to determine the individual flood-producing phenomena.

2.4.3 Probable Maximum Flood on Streams and Rivers

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

In accordance with SRP 2.4.3, in this subsection of the safety analysis report (SAR), the site-specific hydrometeorological design basis is developed by the COL applicant to determine the extent of any flood protection required for those structures, systems, and components necessary to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition. The areas of presentation include the probable maximum precipitation (PMP) potential and precipitation losses over the applicable drainage area, the runoff response characteristics of the watershed, the accumulation of flood runoff through river channels and reservoirs, the estimate of the discharge rate trace (hydrograph) of the PMF at the plant site, the determination of PMF water level conditions at the site, and the evaluation of coincident wind-generated wave conditions that could occur with the PMF. Included is a presentation of the details of design bases for site drainage (which is summarized in COL SAR Subsection 2.4.2); a review of the runoff for site drainage areas adjacent to the plant site, including the roofs of safety-related

structures, resulting from potential PMP; and a presentation of the potential effects from erosion and sedimentation. The analyses involve modeling of physical rainfall and runoff processes to estimate the upper level of possible flood conditions adjacent to and on site.

Regulatory Guide 1.59 describes two positions with respect to flood protection for which a PMF estimate is required to determine the controlling design basis conditions. If Regulatory Guide 1.59 Position 1 is chosen, all safety-related systems, structures, and components must be capable of withstanding the effects from the controlling flood design basis. Regulatory Guide 1.59 Position 2 limits the presentation to specific safety-related structures, systems, and components necessary for cold shutdown and maintenance thereof.

Acceptance criteria for SRP 2.4.3 is based on meeting the, requirements of the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of floods.
- 10 CFR Part 100 as it relates to evaluating hydrologic characteristics of the site.

2.4.4 Potential Dam Failures

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

In accordance with SRP 2.4.4, in this section of the safety analysis report (SAR) the COL applicant develops the hydrogeologic design basis to assure consideration in plant design of any potential hazard to the safety-related facilities due to the failure of upstream and downstream water control structures. The areas of presentation include consideration of flood waves from severe breaching of upstream dams and the potential loss of water supply due to failure of a downstream dam, domino-type failures of dams, landslides, and effects of sediment deposition and erosion.

When data are provided to show that seismic events will not cause failures of upstream dams that could produce the governing flood at the plant, this section may be updated to contain additional data and other information to support a contention that the dams are equivalent to seismic Category I structures and will survive a local equivalent of the safe shutdown earthquake (SSE).

Where analyses are provided in support of either a conclusion that a probable maximum flood (PMF) should be the design basis flood for a stream, or that a postulated or arbitrarily assumed dam failure flood is the design basis flood for a stream, the areas of review consist of the following:

- Conservatism of modes of assumed dam failure and deposition of debris downstream.
- Consideration of flood control reservoirs at full pool level.
- Conservatism of coincident flow rates and levels depending on whether failure is postulated with an equivalent SSE coincident with a 25-year flood.
- Flood wave attenuation to downstream dams, or to the site, whichever would be encountered first.
- Potential for multiple dam failures; flood wave effects and potential for failure of downstream dams.

- Hydraulic failure as a result of overtopping for any reason.
- Dynamic effects of possible waves on exposed plant facilities.
- Conservative flow conditions for downstream dam failures that can influence safety-related water supplies.
- Applicability and conservatism of models used to predict the effects of dam failure floods including breach shape and rate of failure.

Acceptance criteria are based on meeting the requirements of the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems and components important to safety being designed to withstand floods.
- 10 CFR Part 100 as it relates to evaluating hydrologic features of the site.
- 10 CFR Part 100, Appendix A as it relates to establishing the design basis flood due to seismic dam failure.

2.4.5 Probable Maximum Surge and Seiche Flooding

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

In accordance with SRP 2.4.5, in this section of the safety analysis report (SAR) the COL applicant develops the hydrometeorological design basis to determine the extent of flood protection required for safety-related plant systems. The areas of review include the characteristics of the assumed probable maximum hurricane or other probable maximum wind storms and the techniques, methodologies, and parameters used in the determination of the design surge and/or seiche. Antecedent water levels, storm tracks, methods of analysis, coincident wind-generated wave action and wave runup on safety-related structures, potential for wave oscillation at the natural periodicity, and the resultant design bases for surge and seiche flooding are also presented.

Acceptance criteria are based on meeting the requirements of the following regulations:

- General Design Criteria 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes and seiches.
- 10 CFR Part 100 as it relates to evaluating the hydrologic characteristics of the site.

2.4.6 Probable Maximum Tsunami Flooding

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

In accordance with SRP 2.4.6, the COL applicant develops the geohydrological design basis of the plant (discussed in Regulatory Guide 1.59) in this section of the safety analysis report (SAR) to determine the extent of plant protection required for tsunami flooding and drawdown (outlined in Regulatory Guide 1.102). The areas of presentation include the hydrologic characteristics of the maximum locally and distantly generated tsunami and the techniques, methodologies and parameters, including the geoseismic parameters of the generators, used in the determination of the design basis tsunami.

Hydrologic analysis techniques, including tsunami formation, propagation and shoaling models, and coincident water levels, including astronomical tide, storm surges and waves, are presented.

The presentation will include the geologic and seismic characteristics of potential tsunamic faults. Areas of presentation include earthquake magnitude, focal depth, source dimensions, fault orientation, and vertical displacement.

Acceptance criteria relate to the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of tsunami.
- 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site.
- 10 CFR Part 100, Appendix A as it relates to investigating the tsunami potential at the site and determining the design bases for tsunami flooding.

2.4.7 Ice Effects

ESBWR DCD: None; the plant design has no safety-related service water system to be affected by ice flooding or blockage.

In accordance with SRP 2.4.7, the COL applicant develops the hydrometeorologic design basis in this section of the safety analysis report (SAR) to assure that safety-related facilities and water supply are not affected by ice flooding or blockage. The areas of presentation include:

- The regional history and types of historical ice accumulations (i.e., ice jams, wind-driven ice ridges, floes, etc.).
- The potential for ice-produced forces on, or blockage of, safety-related facilities.
- The potential effects of ice-induced high or low flow levels on safety related facilities and water supplies.

If there is evidence of potential structural effects, they shall be properly considered in the structural design basis for the plant; similarly, if there is evidence of potential mechanical effects, they shall be properly considered in the mechanical design basis for the plant.

Acceptance criteria are based on meeting the requirements of the following regulations:

- 10 CFR Part 50, §50.55a as it requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.
- General Design Criterion 2 (GDC 2) as it requires structures, systems, and components important to safety to be designed to withstand the effects of natural phenomena.
- 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site.

Appropriate sections of the following documents are used to assure that the Commission regulations identified above are met:

- Regulatory Guide 1.59 provides guidance for developing the hydrometeorological design basis;
- Regulatory Guide 1.29 identifies the safety-related structures, systems, and components;

- Regulatory Guide 1.102 describes acceptable flood protection to prevent the safety-related facilities from being adversely affected; and
- Regulatory Guide 1.27 describes the ultimate heat sink capabilities that apply.

2.4.8 Cooling Water Canals and Reservoirs

ESBWR DCD: None; the plant design has no safety-related service water system that would require transport and impoundment of plant cooling water.

In accordance with SRP 2.4.8, this section of the COL applicant's SAR presents the basis for the hydraulic design of canals and reservoirs used to transport and impound plant cooling water. In addition, the hydraulic design basis for protection of structures (e.g., riprap) is presented. For canals, the areas of discussion include the design basis for capacity, protection against wind waves, erosion, sedimentation buildup, and freeboard, and (where applicable) the ability to withstand a Probable Maximum Flood (PMF), surges, etc. For reservoirs, the areas of discussion include the design basis for capacity, PMF design basis, wind wave and runup protection, discharge facilities (low level outlet, spillway, etc.), outlet protection, freeboard, and erosion and sedimentation processes.

Acceptance criteria relate to the following regulations:

- 10 CFR Part 50, §50.55a requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.
- General Design Criterion 2 (GDC 2) requires structures, systems, and components important to safety to be designed to withstand the effects of floods.
- General Design Criterion 44 (GDC 44) requires an ultimate heat sink capable of accepting the plant's heat load under normal and accident conditions.
- 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.

2.4.9 Channel Diversions

ESBWR DCD: None; the plant design has no safety-related service water system that would be adversely affected by natural stream channel diversion.

In accordance with SRP 2.4.9, in this section of the COL applicant's safety analysis report (SAR), the geohydrologic design basis is developed to assure that the plant and essential water supplies will not be adversely affected by natural stream channel diversion, or that in such an event, alternate water supplies are available to safety-related equipment.

The review includes:

- Historical channel diversions, including cutoffs and subsidence.
- Regional topographic evidence that suggests future channel diversion may or may not occur (used in conjunction with evidence of historical diversions).
- Alternate water sources and operating procedures (COL SAR Section 2.4).

Acceptance criteria relate to the following regulations:

- General Design Criterion 2 (GDC 2) requires that structures, systems, and components important to safety be designed to withstand floods.
- General Design Criterion 44 (GDC 44) requires an ultimate heat sink capable of accepting the plant's heat load under normal and accident conditions.
- 10 CFR Part 100 requires that hydrological characteristics be considered in the evaluation of the site.

2.4.10 Flooding Protection Requirements

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

In accordance with SRP 2.4.10, the COL applicant describes the locations and elevations of safety-related facilities and of structures and components required for protection of safety-related facilities are compared with the estimated static and dynamic effects of design basis flood conditions identified in safety analysis report (SAR) Subsection 2.4.2.2, to determine whether flood effects need be considered in plant design or emergency procedures.

If flood protection is required, the type of flood protection ("hardened facilities", sandbags, flood doors, bulkheads, etc.) is presented. Any emergency procedures required to implement flood protection and warning times available for implementation thereof are discussed, based on the flood conditions identified in other sections.

If there is evidence of potential structural effects, these effects are presented in the structural design bases for the plant; similarly, these effects are also considered in the systems design bases for the plant.

Acceptance criteria relate to the following regulations:

- 10 CFR Part 50, §50.55a requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.
- General Design Criterion 2 (GDC 2) requires structures, systems, and components important to safety to be designed to withstand the effects of floods.
- 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.

2.4.11 Cooling Water Supply

ESBWR DCD: None; the plant design has no safety-related service water system that would require that a water supply exist to operate the plant or maintain safe shutdown under normal and emergency conditions.

In accordance with SRP 2.4.11, this section of the COL applicant's safety analysis report (SAR) shall identify natural events that may reduce or limit the available cooling water supply, and to assure that an adequate water supply will exist to operate the plant or maintain safe shutdown under normal and emergency conditions.

Depending on the site, the areas of consideration include:

- The worst drought considered reasonably possible in the region.

- Low water (setdown) resulting from surges, seiches, or tsunami.
- Low water resulting from icing.
- The effect of existing and proposed water control structures (dams, diversions, dam failures, etc.).
- The intake structure and pump design basis in relation to the events described in COL SAR Subsections 2.4.11.1, 2.4.11.2, 2.4.11.3 and 2.4.11.4.
- The use limitations imposed or under discussion by Federal, state, or local agencies authorizing the use of the water.
- The range of water supply required by the plant, including minimum operating and shutdown flows, compared to availability.
- The effects of potential blockage of intakes by sediment and littoral drift.
- The capability of the ultimate heat sink to provide adequate cooling water under normal and emergency conditions.

Acceptance criteria for this SRP section relate to the following regulations:

- General Design Criterion (GDC) 2 requires that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena.
- General Design Criterion (GDC) 44 requires an ultimate heat sink capable of accepting the plant's heat load under normal and accident conditions.
- 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.
- 10 CFR Part 100, Appendix A requires, in part, that consideration of river blockages or diversion or other failures which may block the flow of cooling water, tsunami runup and drawdown, and dam failures be included in the evaluation of the adequacy of the emergency cooling water supply.

2.4.11.1 Low Flow in Rivers and Streams

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.2 Low Water Resulting from Surges, Seiches or Tsunami

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.3 Historical Low Water

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.4 Future Controls

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.5 Plant Requirements

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.6 Heat Sink Dependability Requirements

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.12 Groundwater

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

In accordance with SRP 2.4.12, in this subsection of the SAR the COL applicant presents data on local and regional groundwater reservoirs to establish the effects of groundwater on plant foundations. Other areas presented under this subsection include identification of the aquifers and the type of onsite groundwater use, the sources of recharge, present and future withdrawals, monitoring and protection requirements, and design bases for groundwater levels and hydrodynamic effects of groundwater on safety-related structures and components. Flow rates, travel time, gradients, other properties pertaining to the movement of accidental contamination, and groundwater levels beneath the site are presented, as are seasonal and climatic fluctuations, or those caused by man, that have the potential for long-term changes in the local groundwater regime.

Acceptance criteria for this subsection relate to the following regulations:

- 10 CFR Part 50, §50.55 requires that significant deficiencies in construction of or significant damage to a structure, system, or component which will require extensive redesign, or extensive repair to meet the criteria of the construction permit be reported to the Commission.
- 10 CFR Part 50, §50.55a requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.
- General Design Criterion 2 requires structures, systems, and components important to safety to be designed to withstand the effects of natural phenomena.
- General Design Criterion 4 requires structures, systems, and components important to safety to be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation and postulated accidents.
- General Design Criterion 5 requires that structures, systems, and component important to safety not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions.
- 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.
- 10 CFR Part 100, Appendix A sets forth the criteria to determine the suitability of plant design bases with respect to seismic characteristics of the site. It also requires that the adequacy of the cooling water supply for emergency and long-term shutdown decay heat removal be assured, taking into account information concerning the physical, including hydrological, properties of the materials underlying the site.

2.4.12.1 Regional and local groundwater aquifers, sources, and sinks

COL applicant to supply site-specific information in accordance with SRP 2.4.12.

2.4.12.2 Present and projected local and regional groundwater use

COL applicant to supply site-specific information in accordance with SRP 2.4.12.

2.4.12.3 Need for and extent of procedures and measures to protect present and projected groundwater users

COL applicant to supply site-specific information in accordance with SRP 2.4.12.

2.4.12.4 Design bases for groundwater-induced loadings on subsurface portions of safety-related structures, systems, and components

COL applicant to supply site-specific information in accordance with SRP 2.4.12.

2.4.13 Accidental Releases of Liquid Effluents in Ground and Surface Waters

ESBWR DCD: See Section 15.3 “Liquid Containing Tank Failure”.

In accordance with SRP 2.4.13, in this subsection the COL applicant presents site-specific information including the ability of the ground and surface water environment to delay, disperse, dilute, or concentrate accidental radioactive liquid effluent releases with emphasis on relating the effects of such releases to existing and known future uses of ground and surface water resources. (Note that effects of normal releases and of the more likely accidents are discussed in the COL applicant's environmental report and the Limiting Radiological Release Accidents are presented in Chapter 15 of the COL applicant’s SAR).

Acceptance criteria for this subsection relate to 10 CFR Part 100 as it requires that hydrologic characteristics of the site be evaluated with respect to the consequences of the escape of radioactive material from the facility.

To meet the requirements of 10 CFR Part 100 with respect to accidental releases of liquid effluents, the following specific criteria are used.

- Radionuclide transport characteristics of the groundwater environment with respect to existing and future users are described. Estimates and bases for coefficients of dispersion, adsorption, groundwater velocities, travel times, gradients, permeabilities, porosities, and groundwater or piezometric levels between the site and existing or known future surface and groundwater users must be described and be consistent with site characteristics. Potential pathways of contamination to groundwater users must also be identified. Sources of data must be described and referenced.
- Transport characteristics of the surface water environment with respect to existing and known future users must be described for conditions which reflect worst case release mechanisms and source terms so as to postulate the most pessimistic contamination from accidentally released liquid effluents. Estimates of physical parameters necessary to calculate the transport of liquid effluent from the points of release to the site of existing or known future users must be described. Potential pathways of contamination to surface water users must be identified. Sources of information and data must be described and referenced. Acceptance is based on the credibility of the applicant's computational methods and the apparent completeness of the set of parameters necessary to perform the analysis.
- Mathematical models are acceptable to analyze the flow field and dispersion of contaminants in ground and surface waters, providing that the models have been verified

by field data and that conservative site-specific hydrologic parameters are used. Furthermore, conservatism must be the guide in selecting the proper model to represent a specific physical situation. Radioactive decay and sediment adsorption may be considered, if applicable, providing that the adsorption factors are conservative and site-specific. Regulatory Guide 1.113 provides guidance in selecting and using surface water models.

2.4.14 Technical Specification and Emergency Operation Requirements

ESBWR DCD: See DCD Tier-2 Chapters 16 and 18; the ESBWR plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

In accordance with SRP 2.4.14, the purpose of this subsection of the COL applicant's SAR is to identify the technical specifications and emergency procedures required to implement flood protection for safety-related facilities and to assure an adequate water supply for shutdown and cooldown purposes.

If there is evidence of potential structural effects, the COL applicant will demonstrate that these effects are properly considered in the structural design bases for the plant; similarly, the COL applicant will demonstrate that these effects are properly considered in the systems design bases for the plant.

Acceptance criteria for this subsection is based on meeting the relevant requirements of the following regulations:

- 10 CFR Part 50, §50.36 as it relates to requiring technical specifications to be derived from safety evaluations.
- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes, floods, tsunami, and seiches.

To meet the requirements of the hydrologic aspects of 10 CFR Part 50, §50.36 and General Design Criterion 2 with respect to Technical Specifications and emergency operation requirements the following specific criteria are used:

If the hydrologic design bases developed in preceding sections do not necessitate technical specifications or emergency procedures to ensure safety-related plant functions (i.e., Position 1 of Regulatory Guide 1.59 is met), this section should so state. If Technical Specifications or emergency procedures in compliance with position 2 of Regulatory Guide 1.59 are necessary this section will be acceptable if the following are identified.

- The controlling hydrologic events, as developed in the preceding sections of COL SAR Chapter 2.
- The actions to be taken, and the effect of such actions on the protection of safety-related facilities and water supplies.
- The appropriate water levels and conditions at which action is to be initiated.
- The appropriate emergency procedures, and the amount of time required to implement each procedure. Regulatory Guide 1.102, position 2 provides guidance in establishing appropriate procedures.

2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

2.5.1 Basic Geologic and Seismic Information

ESBWR DCD: None; see Items 2.5.2-2.5.5 of Table 2.0-1 for ESBWR bounding parameters and assumptions.

In accordance with SRP 2.5.1, 2.5.2, and 2.5.3, in these sections the COL applicant will present results largely from surface and subsurface geological, seismological, geophysical, and geotechnical investigations performed in progressively greater detail closer to the site, within each of the areas described by radii of 320 km (200 mi), 40 km (25 mi), 8 km (5 mi), and 1 km (0.6 mi) around the site. The following specific subjects are addressed: tectonic and seismic information, nontectonic deformation information, and conditions caused by human activities, with respect to regional geology (Subsection 2.5.1.1) and site geology (Subsection 2.5.1.2). The COL applicant's information describing the preloading history of the plant's soil foundations by means of glacial and other geologic processes is presented in the COL Applicant's SAR Subsection 2.5.4. The principal regulation used to determine the scope and adequacy of the submitted geological, seismological, and geophysical information for nuclear power plant sites is 10 CFR Part 100, Section 100.23, "Seismic and Geologic Siting Factors."

The geological, seismological, and geophysical information that must be provided by the COL applicant for the site review to proceed is divided into the following three basic categories:

- Tectonic or Seismic Information. Information regarding tectonics, (particularly Quaternary tectonics), seismicity, correlation of seismicity with tectonic structure, characterization of seismic sources, and ground motion. Seismicity and vibratory ground motions are primary review responsibilities addressed in SRP Subsection 2.5.2. However, the review and acceptance of the applicant's basic data-gathering processes and findings that are presented in support of these topics, and their completeness, are also integral parts of the review responsibilities covered in this section. There must be close coordination among geologists, geophysicists, and seismologists in reviewing these sections.

  Sufficient information must be provided to estimate the potential for strong earthquake ground motions or surface deformation at the site, such as the proximity and nature of potential seismic sources, Quaternary geological evidence for faulting, folding, prehistoric earthquakes (i.e., paleoliquefaction features), and other seismically induced features. A complete presentation, including supporting basic data, of the characteristics of the subsurface materials beneath the site must be provided (or cross-referenced with SRP Section 2.5.4) and reviewed by the staff so that an assessment of the potential for amplification of vibratory ground motion or ground failure under dynamic loading can be made. Potential ground failure modes may include liquefaction, excessive settlement, differential settlement, and those caused by high tectonic stresses. Additionally, for sites adjacent to large bodies of water, information pertinent to estimating tsunami and seiche hazards must be provided or cross-referenced to SRP Section 2.4.12.

- Nontectonic Deformation Information. Adequate information must be provided for an assessment of other nontectonic geological hazards, such as landsliding and other mass-wasting phenomena, subsidence (including differential subsidence), growth faulting, glacially induced deformation, chemical weathering, the potential for collapse or subsidence in areas underlain by carbonate rocks, evidence of preconsolidation, etc.

- Conditions Caused by Human Activities. Information on changes in groundwater conditions caused by the withdrawal or injection of fluids, subsidence or collapse caused by withdrawal of fluids, mineral extraction, induced seismicity and fault movement caused by reservoir impoundment, fluid injection or withdrawal must be included in the SAR and evaluated by the ECGB staff.

Acceptance criteria related to the above conditions are presented in SRP Subsections 2.5.1.1, "Regional Geology," and 2.5.1.2, "Site Geology." Information provided by the applicant in the SAR in support of its application for a license should be reviewed in terms of the regional and site tectonics, with emphasis on the Quaternary period, structural geology, physiography, geomorphology, stratigraphy, and lithology. In addition, with specific reference to site geology, the following subjects should be reviewed as they relate to the above-mentioned conditions: topography, slope stability, fluid injection or withdrawal, mineral extraction, faulting, solutioning, jointing, seismicity, and fracturing.

The information provided should be documented by appropriate references to all relevant published and unpublished materials. Illustrations such as maps and cross sections should include but should not be limited to structural, tectonic, physiographic, topographic, geologic, gravity, and magnetic maps; structural and stratigraphic sections; boring logs; and aerial photographs. Some sites may require maps of subsidence, irregular weathering conditions, landslide potential, hydrocarbon extraction (oil or gas wells), faults, joints, and karst features. Some site characteristics must be documented by reference to seismic reflection or refraction profiles or to maps produced by various remote sensing techniques.

Maps should include superimposed plot plans of the plant facilities. Other documentation should show the relationship of all Seismic Category I facilities (clearly identified) to subsurface geology. Core boring logs, logs and maps of trenches, aerial photographs, satellite imagery, and geophysical data should be presented for evaluation. In addition, plot plans showing the locations of all plant structures, borings, trenches, profiles, etc., should be included.

The review can be brought to an earlier conclusion if the SAR contains sufficient data to allow the reviewers to make an independent assessment of the applicant's conclusions. The reviewers should be led in a logical manner from the data and premises given to the conclusions that are drawn without having to make an extensive independent literature search. A literature search will be conducted by the staff at the appropriate level of detail, depending on the completeness of the SAR. All pertinent data, including that which is controversial, should be presented and evaluated. The geologic terminology used should conform to standard reference works.

The primary purposes for conducting the site and regional investigations are to determine the geological and seismological suitability of the site, provide the bases for the design of the plant, and determine whether there is significant new tectonic or ground motion information that could impact the seismic design bases as determined by a probabilistic seismic hazard analysis (PSHA). The objective of Section 2.5.1 of the SAR is to present the results of these investigations and to describe geologic and seismic features as they affect the site under review; all data, information, discussions, interpretations, and conclusions should be directed to this objective.

The applicable regulations and regulatory guides and basic acceptance criteria pertinent to the areas of this section of the Standard Review Plan are:

- General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50. This criterion requires that the structures, systems, and components important to safety be designed to withstand the effects of earthquakes, tsunamis, and seiches without loss of capability to perform their safety functions.
- Section 100.23, "Geologic and Seismic Siting Factors." of 10 CFR Part 100. This section of Part 100 requires the applicant to determine the SSE and its uncertainty, the potential for surface tectonic and nontectonic deformations, the design bases for seismically induced floods and water waves, and other design conditions.
- Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion." This guide describes acceptable methods to: (1) conduct geological, seismological, and geophysical investigations of the site and region around the site, (2) identify and characterize seismic sources, (3) perform PSHA, and (4) determine the SSE for the site (see SRP Subsection 2.5.2.6).
- Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants." This guide describes programs of site investigations related to geotechnical aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundations and earthworks under anticipated loading conditions, including earthquakes. It provides general guidance and recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, such as borings and sampling.
- Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." This guide discusses the major site characteristics related to public health and safety that the NRC staff considers in determining the suitability of sites for nuclear power stations.

2.5.1.1 Regional Geology

COL applicant to provide site-specific information in accordance with SRP 2.5.1.

2.5.1.2 Site Geology

COL applicant to provide site-specific information in accordance with SRP 2.5.1.

2.5.2 Vibratory Ground Motion

ESBWR DCD: Safe Shutdown Earthquake (SSE) design ground response spectra are the envelope of 0.3g Regulatory Guide 1.60 generic site spectra and North Anna ESP site-specific spectra at foundation level in the free-field as shown in Figures 2.5-1 and 2.5-2 in the horizontal and vertical directions, respectively.

In accordance with SRP 2.5.2, in this subsection the COL applicant covers the seismological, geological, geophysical, and geotechnical investigations carried out to determine the safe shutdown earthquake (SSE) ground motion for the site. The SSE represents the design earthquake ground motion at the site and is the vibratory ground motion for which certain structures, systems, and components are designed to remain functional. The SSE is based upon a detailed evaluation of earthquake potential, taking into account regional and local geology, Quaternary tectonics, seismicity, and specific geotechnical characteristics of the site's subsurface material. The SSE is defined as the free-field horizontal and vertical ground response spectra at

the plant site. The principal regulation used by the staff in determining the scope and adequacy of the submitted seismologic and geologic information and attendant procedures and analyses is 10 CFR 100.23 “Geologic and Seismic Siting Factors.” Guidance on seismological and geological investigations is provided in Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion." These investigations describe the seismicity of the site region and the correlation of earthquake activity with seismic sources. Seismic sources are identified and characterized, including the rates of occurrence of earthquakes associated with each seismic source. Seismic sources that have any part within 320 km (200 miles) of the site must be identified. More distant sources that have a potential for earthquakes large enough to affect the site must also be identified. Seismic sources can be capable tectonic sources or seismogenic sources; a seistnotectonic province is a type of seismogenic source.

The geotechnical engineering aspects of the site and the models and methods employed in the analysis of soil and foundation response to the ground motion environment are presented under COL SAR Subsection 2.5.4. The results of the geosciences development are used in COL SAR Subsections 3.7.1 and 3.7.2.

The applicable regulations and regulatory guides and basic acceptance criteria pertinent to the areas of this subsection are:

- 10 CFR Part 100, “Reactor Site Criteria.” This part of the NRC's regulations describes general criteria that guide the evaluation of the suitability of proposed sites for nuclear power and test reactors.

  Section 100.23, "Geologic and Seismic Siting Factors." of 10 CFR Part 100. This section of Part 100 requires the applicant to determine the SSE and its uncertainty, the potential for surface tectonic and nontectonic deformations, the design bases for seismically induced floods and water waves, and other design conditions.

- General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50. This criterion requires that the structures, systems, and components important to safety be designed to withstand the effects of earthquakes, tsunamis, and seiches without loss of capability to perform their safety functions.

- Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants." This guide describes programs of site investigations related to geotechnical aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundations and earthworks under anticipated loading conditions, including earthquakes. It provides general guidance and recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, such as borings and sampling.

- Regulatory Guide 4.7, “General Site Suitability Criteria for Nuclear Power Stations.” This guide discusses the major site characteristics related to public health and safety that the NRC staff considers in determining the suitability of sites for nuclear power stations.

- Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants." Smoothed response spectra are generally used for design purposes — for example, a standard spectral shape that has been used in the past is presented in Regulatory Guide 1.60. These smoothed spectra are still acceptable when the smoothed

design spectra compare favorably with site-specific response spectra derived from the ground motion estimation procedures discussed in Subsection 2.5.2.6.

- Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion." This guide describes acceptable methods to:
  - conduct geological, seismological, and geophysical investigations of the site and region around the site,
  - identify and characterize seismic sources,
  - perform PSHA, and
  - determine the SSE for the site (see SRP Subsection 2.5.2.6).

2.5.2.1 Seismicity

COL applicant to provide site-specific information in accordance with SRP 2.5.2.

2.5.2.2 Geologic and Tectonic Characteristics of Site and Region

COL applicant to provide site-specific information in accordance with SRP 2.5.2.

2.5.2.3 Correlation of Earthquake Activity with Seismic Sources

COL applicant to provide site-specific information in accordance with SRP 2.5.2.

2.5.2.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes

COL applicant to provide site-specific information in accordance with SRP 2.5.2.

2.5.2.5 Seismic Wave Transmission Characteristics of the Site

COL applicant to provide site-specific information in accordance with SRP 2.5.2.

2.5.2.6 Safe Shutdown Earthquake

COL applicant to provide site-specific information in accordance with SRP 2.5.2.

2.5.3 Surface Faulting

ESBWR design assumes no faulting at or near the ground surface.

In accordance with SRP 2.5.3, in this subsection the COL applicant provides site-specific information related to the existence of a potential for surface deformation that could affect the site. The technical information presented in this section results largely from detailed surface and subsurface geological, seismological, and geophysical investigations performed in progressively greater detail within each of the areas approximately described by radii of 40 km (25 mi), 8 km (5 mi), and 1 km (0.6 mi) around the site.

The applicable regulations and regulatory guides and basic acceptance criteria pertinent to the areas of this section of the Standard Review Plan are:

- General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50. This criterion requires that the structures, systems, and components

important to safety be designed to withstand the effects of earthquakes, tsunamis, and seiches without loss of capability to perform their safety functions.

- Section 100.23, "Geologic and Seismic Siting Factors." of 10 CFR Part 100. This section of Part 100 requires the applicant to determine the SSE and its uncertainty, the potential for surface tectonic and nontectonic deformations, the design bases for seismically induced floods and water waves, and other design conditions.
- Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion." This guide describes acceptable methods to:
  - conduct geological, seismological, and geophysical investigations of the site and region around the site,
  - identify and characterize seismic sources,
  - perform PSHA, and
  - determine the SSE for the site (see SRP Subsection 2.5.2.6).
- Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants." This guide describes programs of site investigations related to geotechnical aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundations and earthworks under anticipated loading conditions, including earthquakes. It provides general guidance and recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, such as borings and sampling.
- Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." This guide discusses the major site characteristics related to public health and safety that the NRC staff considers in determining the suitability of sites for nuclear power stations.

2.5.3.1 Geological, Seismological, and Geophysical Investigations

COL applicant to provide site-specific information in accordance with SRP 2.5.3.

2.5.3.2 Geological Evidence, or Absence of Evidence, for Surface Deformation

COL applicant to provide site-specific information in accordance with SRP 2.5.3.

2.5.3.3 Correlation of Earthquakes with Capable Tectonic Sources

COL applicant to provide site-specific information in accordance with SRP 2.5.3.

2.5.3.4 Ages of Most Recent Deformations

COL applicant to provide site-specific information in accordance with SRP 2.5.3.

2.5.3.5 Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures

COL applicant to provide site-specific information in accordance with SRP 2.5.3.

2.5.3.6 Characterization of Capable Tectonic Sources

COL applicant to provide site-specific information in accordance with SRP 2.5.3.

2.5.3.7 Designation of Zones of Quaternary Deformation in the Site Region

COL applicant to provide site-specific information in accordance with SRP 2.5.3.

2.5.3.8 Potential for Surface Tectonic Deformation at the Site

COL applicant to provide site-specific information in accordance with SRP 2.5.3.

2.5.4 Stability of Subsurface Materials and Foundations

ESBWR DCD: See Table 2.0-1 for ESBWR bounding parameters and assumptions.

In accordance with SRP 2.5.4, in this COL SAR subsection information is presented by the COL applicant concerning the properties and stability of all soils and rock which may affect the nuclear power plant facilities, under both static and dynamic conditions including the vibratory ground motions associated with the safe shutdown earthquake. Stability of these materials, as they influence the safety of Seismic Category I facilities, must be demonstrated. In addition an assessment of the properties and stability of these materials should be consistent with SRP and COL SAR Sections 3.7 and 3.8. Much of the information discussed in this section may be presented in other sections, in which case it may be cross-referenced rather than repeated here.

2.5.4.1 Geologic features in the vicinity of the site

COL applicant to provide site-specific information in accordance with SRP 2.5.4, to include discussion of the following features:

- Areas of actual or potential surface or subsurface subsidence, solution activity, uplift, or collapse.
- Zones of alteration or irregular weathering profiles, and zones of structural weakness.
- Unrelieved stresses in bedrock and their potential for creep and rebound effects.
- Rocks or soils that might be unstable because of their mineralogy, lack of consolidation, water content, or potentially undesirable response to seismic or other events.
- History of deposition and erosion, including glacial and other preloading influence on soil deposits.

2.5.4.2 Static and dynamic engineering properties of soil and rock strata underlying the site

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.3 Relationship of the foundations for safety-related facilities and the engineering properties of underlying materials as illustrated on plot plans and profiles

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.4 Results of seismic refraction and reflection surveys, including in-hole and cross-hole explorations

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.5 Safety-related excavation and backfill plans and engineered earthwork analyses and criteria

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.6 Groundwater conditions and piezometric pressure in all critical strata

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.7 The responses of site soils or rocks to dynamic loading

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.8 Liquefaction potential

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.9 Earthquake design bases

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.10 Results of investigations and analyses conducted to determine foundation material stability, deformation and settlement under static conditions

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

2.5.4.11 Criteria, references, and design methods

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

Additional information on foundations is covered in SRP Subsection 3.8.5 and is cross-referenced to this section.

2.5.4.12 Techniques and specifications to improve subsurface conditions

COL applicant to provide site-specific information in accordance with SRP 2.5.4.

The applicable rules and basic acceptance criteria pertinent to Subsection 2.5.4 are:

- 10 CFR Part 50, §50.55a - Codes and Standards. This rule requires that structures, systems, and components shall be designed, fabricated, erected, constructed, tested and inspected in accordance with the requirement of applicable codes and standards commensurate with the importance of the safety function to be performed.
- 10 CFR Part 50, Appendix A:
  - General Design Criterion 1 - "Quality Standards and Records." This criterion requires that structures, systems and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. It also requires that appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.
  - General Design Criterion 2 - "Design Bases for Protection Against Natural Phenomena." This criterion requires that safety-related portions of the system shall

be designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

- General Design Criterion 44 - "Cooling Water" - This criterion requires that a system shall be provided with the safety function of transferring the combined heat load from structures, systems, and components important to safety to an ultimate heat sink under normal operating and accidental conditions.

- 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." This appendix establishes quality assurance requirements for the design, construction, and operation of those structures, systems, and components of nuclear power plants that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public.
- 10 CFR Part 100, "Reactor Site Criteria." This part describes criteria that guide the evaluation of the suitability of proposed sites for nuclear power and testing reactors.
- 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants." These criteria describe the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants.

The following Regulatory Guides provide information, recommendations, and guidance and in general describe a basis acceptable to the staff that may be used to implement the requirements of 10 CFR Part 50, §50.55a; 10 CFR Part 50, Appendix A, General Design Criteria 1, 2 and 44; 10 CFR Part 50, Appendix B; 10 CFR Part 100; and 10 CFR Part 100, Appendix A.

- Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants." This guide describes a basis acceptable to the staff that may be used to implement General Design Criteria 2 and 44 with regard to the ultimate heat sink, including necessary retaining structures and the canals and conduits connecting the ultimate heat sink with the cooling water system intake structures.

  Note: In the ESBWR design, passive decay heat removal systems provide the ultimate heat sink (UHS) function so a separate reservoir is not needed. The ESBWR UHS is discussed in Section 9.2.5.

- Regulatory Guide 1.28, "Quality Assurance Program Requirements (Design and Construction)." This guide describes a method acceptable to the staff for complying with the Commission's regulations with regard to 10 CFR Part 50, Appendix B, overall quality assurance program requirements during design and construction of nuclear power plants.
- Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants." This guide describes programs of site investigations related to geotechnical engineering aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundation and earthworks under anticipated loading conditions including earthquake in complying with 10 CFR Part 100 and 10 CFR Part 100, Appendix A. It provides general guidance and recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, the spacing and depth of borings and sampling.

- Regulatory Guide 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants." This guide describes laboratory investigations and testing practices acceptable for determining soil and rock properties and characteristics needed for engineering analysis and design for foundations and earthwork for nuclear power plants in complying with 10 CFR Part 100 and 10 CFR Part 100, Appendix A.

2.5.5 Stability of Slopes

ESBWR design assumes stable slopes.

In accordance with SRP 2.5.5, this subsection of the COL applicant's SAR presents information, including analyses and substantiation, concerning the stability of all earth and rock slopes both natural and man-made (cuts, fills, embankments, dams, etc., whose failure, under any of the conditions to which they could be exposed during the life of the plant, could adversely affect the safety of the plant. The following subjects will be evaluated using the applicant's data in the COL SAR and information available from other sources.

2.5.5.1 Slope characteristics

COL applicant to provide site-specific information in accordance with SRP 2.5.5.

2.5.5.2 Design criteria and design analyses

COL applicant to provide site-specific information in accordance with SRP 2.5.5.

2.5.5.3 Results of the investigations including borings, shafts, pits, trenches, and laboratory tests

COL applicant to provide site-specific information in accordance with SRP 2.5.5.

2.5.5.4 Properties of borrow material, compaction and excavation specifications

COL applicant to provide site-specific information in accordance with SRP 2.5.5.

The applicable rules and basic acceptance criteria pertinent to the areas of this subsection are:

- 10 CFR Part 50, §50.55a, "Codes and Standards." This rule requires that structures, systems, and components shall be designed, fabricated, erected, constructed, tested, and inspected in accordance with the requirement of applicable codes and standards commensurate with the importance of the safety function to be performed.
- 10 CFR Part 50, Appendix A:
  - General Design Criterion 1 - "Quality Standards and Records." This criterion requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. It also requires that appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.
  - General Design Criterion 2 - "Design Bases for Protection Against Natural Phenomena." This criterion requires that safety-related portions of the system be designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

  - General Design Criterion 44 - "Cooling Water." This criterion requires that a system shall be provided with the safety function of transferring the combined heat load from structures, systems, and components important to safety to an ultimate heat sink under normal operating and accidental conditions.

- 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." This appendix establishes quality assurance requirements for the design, construction, and operation of those structures, systems, and components of nuclear power plants that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public.
- 10 CFR Part 100, "Reactor Site Criteria." This part describes criteria that guide the evaluation of the suitability of proposed sites for nuclear power and testing reactors.
- 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants." These criteria describe the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants.

The following regulatory guides provide information, recommendations, and guidance and in general describe a basis acceptable to the staff that may be used to implement the requirements of 10 CFR Part 50, §50.55a; 10 CFR Part 50, Appendix A, General Design Criteria 1, 2 and 44; 10 CFR Part 50, Appendix B; 10 CFR Part 100; and 10 CFR Part 100, Appendix A.

- Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants." This guide describes a basis acceptable to the staff that may be used to implement General Design Criteria 2 and 44 with regard to the ultimate heat sink, including necessary retaining structures and the canals and conduits connecting the ultimate heat sink with the cooling water system intake structures.

  Note: In the ESBWR design, passive decay heat removal systems provide the ultimate heat sink (UHS) function so a separate reservoir is not needed. The ESBWR UHS is discussed in Section 9.2.5.

- Regulatory Guide 1.28, "Quality Assurance Program Requirements (Design and Construction)." This guide describes a method acceptable to the staff for complying with the Commission's regulations with regard to 10 CFR Part 50, Appendix B, overall quality assurance program requirements during design and construction of nuclear power plants.
- Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants. " This guide describes programs of site investigations related to geotechnical engineering aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundation and earthworks under anticipated loading conditions including earthquake in complying with 10 CFR Part 100 and 10 CFR Part 100, Appendix A. It provides general guidance and recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, the spacing and depth of borings and sampling.
- Regulatory Guide 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants." This guide describes laboratory investigations and testing practices acceptable for determining soil and rock properties and characteristics

needed for engineering analysis and design for foundations and earthwork for nuclear power plants in complying with 10 CFR Part 100 and 10 CFR Part 100, Appendix A.

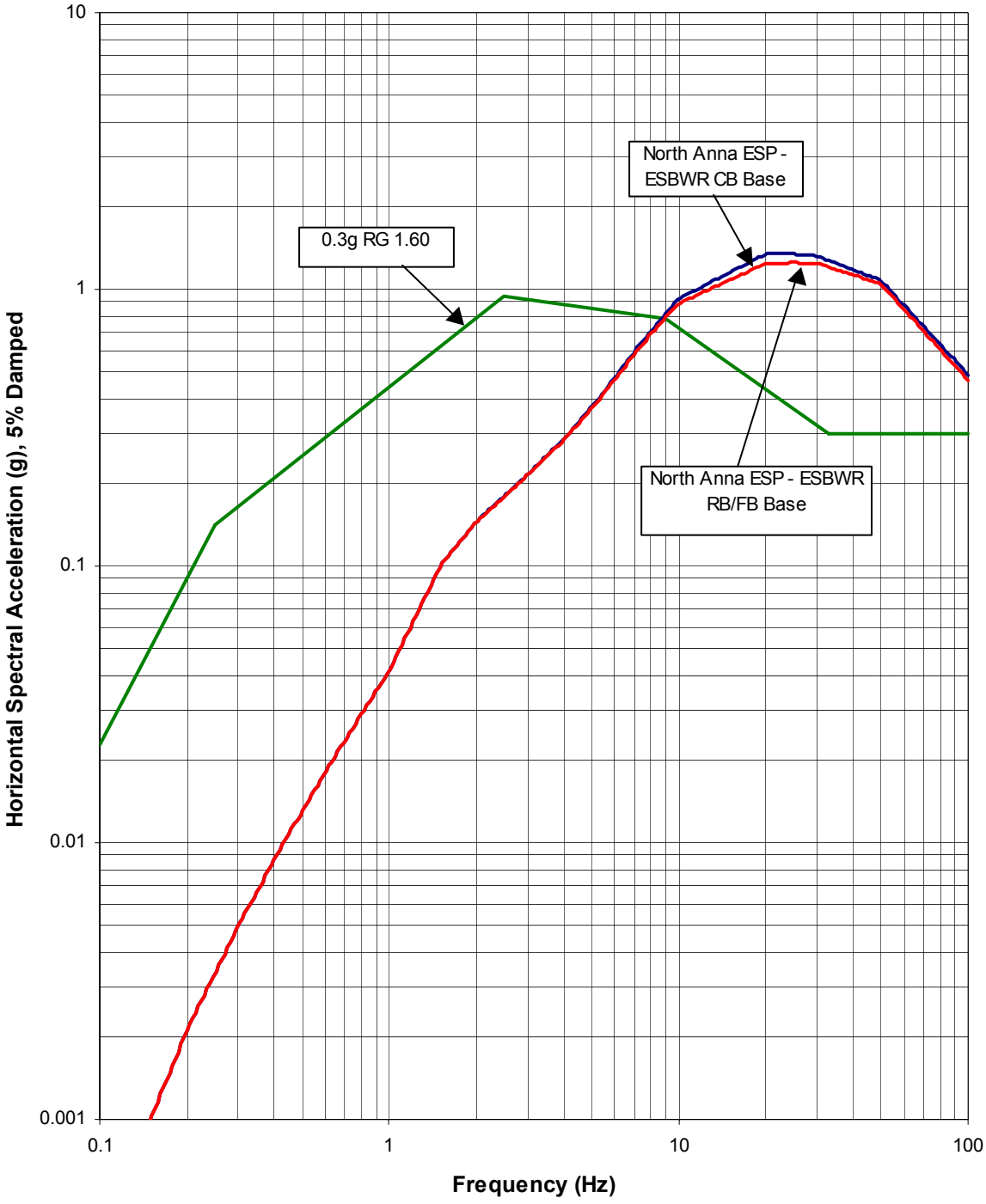

Figure 2.5-1. ESBWR Horizontal SSE Design Ground Spectra at Foundation Level

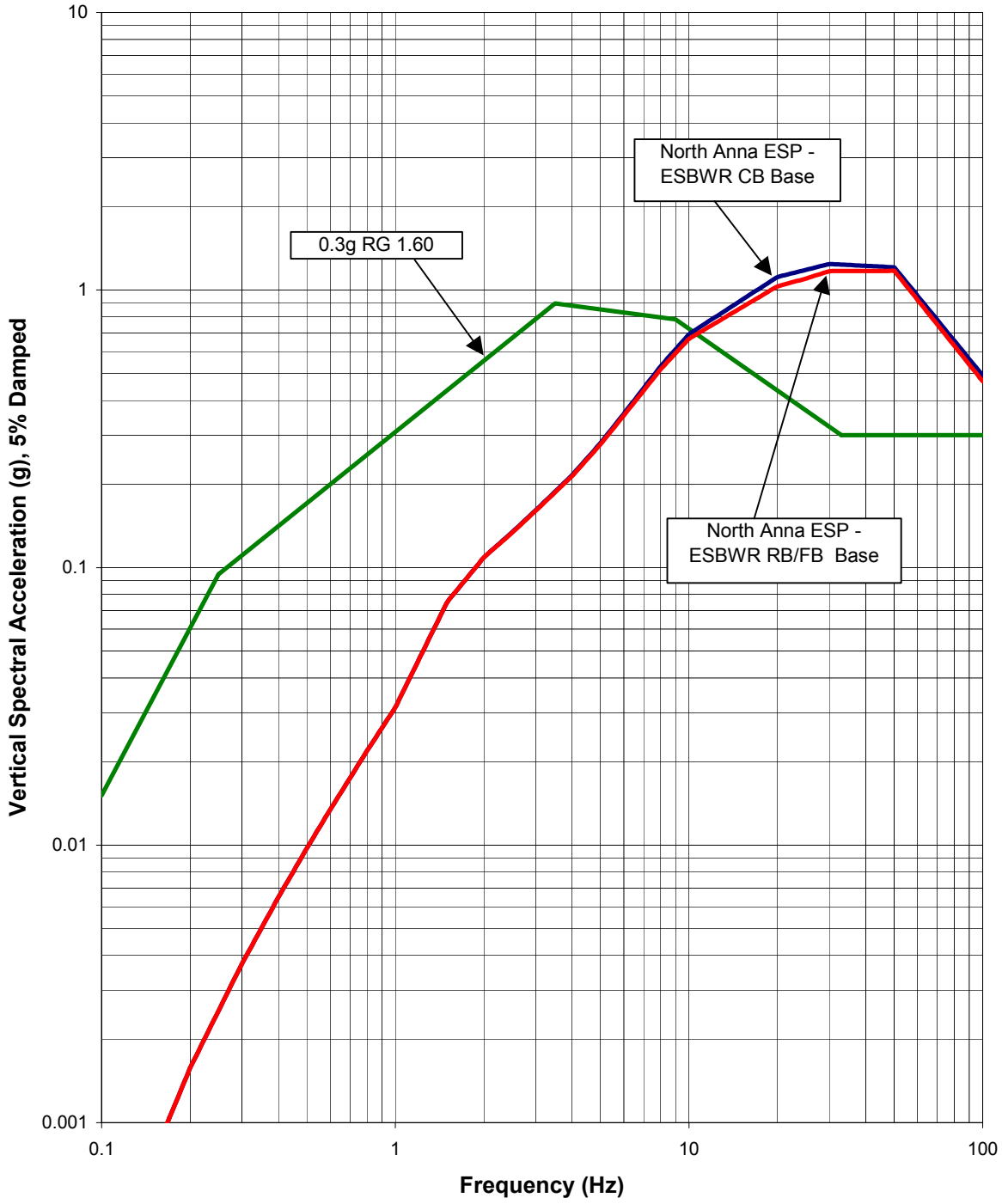

Figure 2.5-2. ESBWR Vertical SSE Design Ground Response Spectra at Foundation Level